The impact of HIV/AIDS in NSW mortality, morbidity and economic impact:

Health Outcomes International Pty Ltd in association with The National HIV Centre in HIV Epidemiology and Clinical Research

NSW HEALTH

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NSW Health AIDS/Infectious Diseases Branch

The Impact of HIV/AIDS in NSW – Mortality, Morbidity and Economic Impact

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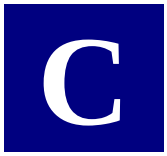

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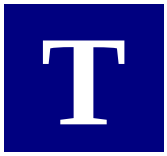
GLOSSARY OF TERMS

AIDS	Acquired immune deficiency syndrome
CALD	Culturally and linguistically diverse
CSW	Commercial sex worker
DALY	Disability Adjusted Life Year
DHA	Department of Health and Ageing
FSW	Female sex worker
HAART	Highly active antiretroviral treatment
HIV	Human immunodeficiency virus
HOI	Health Outcomes International Pty Ltd
HTR (Hetero)	Heterosexual and general population
IDU	Injecting drug user
MSM	Men who have sex with men
NCHECR	National Centre in HIV Epidemiology and Clinical Research
NHMRC	The National Health and Medical Research Council
NPV	Net Present Value
NSP	Needle and syringe program
PLWHA	People living with HIV/AIDS
PV	Present Value
QALY	Quality Adjusted Life Year
STI	Sexually transmitted infection
UAI	Unprotected anal intercourse
YLD	Years of healthy life lost due to disability
YLL	Years of life lost



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EXECUTIVE SUMMARY

E.1 OVERVIEW

This report provides an overview of the historical impact of the HIV/AIDS epidemic in NSW and projects the future impact of HIV/AIDS in NSW. This encompasses an analysis of the economic impact of the epidemic in regard to clinical care costs avoided, the NSW investment in the public health response to HIV/AIDS and the morbidity and mortality arising from HIV/AIDS.

The NSW HIV/AIDS Program encompasses research, primary and secondary prevention, and care, treatment and support for people living with HIV/AIDS. The Strategy provides a framework for collaboration between government, affected communities, researchers and medicine, and seeks to ensure that programs and services are informed by both the best available evidence and the experience of those living with or at risk of HIV infection.

E.2 HISTORICAL TRENDS

The analysis of historical trends of HIV incidence and prevalence undertaken by NCHECR as part of this study found that the number of people with a newly diagnosed HIV infection decreased between 1995 and 2001. Since the nadir of 2001, HIV incidence increased to 2003 and has effectively plateaued since then. Approximately 65% of people with HIV reported primary exposure through male-to-male sexual contact.

Both AIDS diagnoses and deaths peaked in 1994 in NSW, with large declines from 1996 onwards with the availability of combination antiretroviral treatment. This pattern was consistent across most exposure categories, except AIDS diagnoses in people with HIV-infection through heterosexual contact. AIDS diagnoses in this group showed little decline through the 1990s, largely associated with late HIV-diagnosis in this group.

E.3 EPIDEMIOLOGICAL MODEL

The study has examined four identified population groups, namely homosexual men, injecting drug users, the general heterosexual population, and commercial sex workers. These populations represent some of the key priority population groups identified for the Program for which data are available to support the analysis. Due to limited data, explicit modelling of epidemics by indigenous status or ethnicity was not attempted, although migrants from high HIV prevalence countries were included as a part of the modelling of heterosexual transmission.

For each of the study population groups, we examined historical trends in HIV transmission and the risk factors that affect the transmission of HIV. Based on this analysis, models were developed that compare a baseline scenario (reflecting actual HIV transmission rates to date with preventative strategies in place) with modelled alternative scenarios that assume that no intervention strategies were in place, other than antiretroviral therapy. Projections were then made that estimate the number of people living with HIV/AIDS under each scenario from 2005 to 2090, by which time all survivors are estimated to have died. In scenarios where intervention measures for sexual transmission of HIV were absent, it was assumed that the absence of intervention measures accounted for 50% of the estimated change in levels of risk. This takes into

consideration the natural population-driven change in risk behaviour independent of intervention efforts. Lower and upper limits of the impact of interventions on changing risk levels were set at 25% and 75%, respectively. For injecting drug users, the model assumed only the presence or absence of needle and syringe programs for its estimation of effect.

In the medium set of projections developed under these assumptions, the total number of cases of HIV avoided between 1980 and 2005 was estimated at approximately 44,500 cases. Overall, this represents an estimated 80% reduction in the number of new cases of HIV that would otherwise have occurred during this period. The estimated reduction in HIV incidence ranged from 99% among injecting drug users to 50% among those infected by homosexual contact. Injecting drug users comprised 75% of the total cases avoided, with homosexual men comprising 22%.

A separate set of projections was prepared for the HIV epidemic between 2006 and 2016, to assess the likely impact of terminating existing prevention intervention initiatives from 2005. Under the assumptions regarding the impact of cessation of these initiatives on risk behaviours among the various population groups, HIV incidence increases among all groups, particularly injecting drug users. In these projections, an additional 9,100 cases of HIV are estimated would occur from 2006 to 2016 if the current prevention initiatives were to cease at the end of 2005. This would result in an additional 9,000 people living with HIV in 2016, with an associated increase in clinical care costs for the remainder of their lifetime.

E.4 ECONOMIC MODEL

The economic analysis examined the investment made in the HIV/AIDS Program by the NSW Government since 1981, including funds allocated to preventative and clinical care services and activities, together with the clinical care costs avoided as a result of the reduced incidence of HIV associated with the preventative activities. In this context, clinical care costs refer to the direct costs of providing medical and allied health care of HIV/AIDS via public sector facilities and via funded non-government organisations that are met by the NSW Government. These exclude the costs of antiretroviral therapy which are met by the Commonwealth and which are of the order of $10,000 per patient per annum. The NSW Government also makes a small contribution to the cost of Highly Specialised Drugs.

Based on the available data, the study has estimated that a total of $1,259 million was invested in the NSW HIV/AIDS Program between 1981/82 and 2005/06 ($1,606 million in 2005/06 prices). Approximately 70% of this investment was allocated to clinical care services, with 30% ($484 million in 2005/06 prices) allocated to preventative activities. Information provided by NSW Health provided the basis for allocating the preventative funds across various population groups, including the four groups that formed the focus of this study.

The analysis of the return on the investment in preventative activities has considered two aspects;

- The financial value of the direct lifetime costs of clinical care of HIV avoided by the NSW Government, and
- The life years and quality adjusted life years saved as a result of the preventative activities funded under the Program.

The financial return on investment found that a total of $18,027 million (in 2005/06 prices) in clinical care costs that would otherwise be borne by the NSW Government would be saved over the lifetime of the HIV cases avoided by the prevention initiatives funded under the Program. Annual cost savings are expected to peak in 2020 at approximately $483 million, and decrease thereafter as mortality reduces the number of survivors. Of these savings, 75% relate to injecting drug users, 22% to homosexual men, and 4% to the heterosexual population. A total of $38 million in clinical care cost savings are attributed to the commercial sex work group.

Discounting both the investment expenditure and the lifetime costs of clinical care avoided to a common value (the Net Present Value (NPV)) reveals that the HIV/AIDS Program has achieved a positive NPV, indicating that it fulfils the financial expectations of the Program. At a discount rate

of 5%, the NPV of the investment in prevention initiatives made under NSW HIV/AIDS Program to 2005/06 was estimated at $2,105 million. The ratio of clinical care costs avoided to funds invested by the NSW government is approximately 13:1, meaning that for every $1 expended on HIV prevention programs, clinical care cost savings of $13 are achieved. The return on the preventative components of the Program alone was sufficient to offset the total investment in both the clinical care and preventative components of the Program.

Sensitivity analysis on these findings reveals that the results are sustained under both higher and lower estimates of the contribution of the prevention initiatives to the overall reduction in HIV.

The second component of the economic model examined the life years and quality-adjusted life years saved as a result of the investment in preventative initiatives. A total of approximately 394,000 life years are expected to be gained over the lifetime of persons avoiding HIV. Of the total life years saved, 55% relate to injecting drug users, with 38% attributed to homosexual men. Life year gains among heterosexual cases account for a further 6%.

In regard to the impact on quality of life, an estimated 863,000 Quality Adjusted Life Years (QALYs) are expected to be gained over the lifetime of persons who would otherwise have been infected with HIV. The Present Value of these QALYs (i.e. the value placed on them at the beginning of the investment period) was 98,000 QALYs.

A rudimentary comparison of these results with those for several other public health preventative initiatives aimed at reducing tobacco consumption and reducing coronary heart disease indicates that the HIV/AIDS Program compares very favorably in regard to direct health care costs saved and total benefits derived relative to the funds invested. For example, the ratio of clinical care costs saved to funds invested for the HIV/AIDS Program is estimated at 13:1 compared to 2:1 for tobacco reduction strategies, while the ratio of total benefits to funds invested for HIV/AIDS is 189:1 compared to 49:1 for tobacco reduction strategies.

E.5 CONCLUSION

The investment in the NSW HIV/AIDS Program has been a major public health initiative, and has been in place since the early 1980s. Four of the specific populations targeted in the preventative initiatives funded under the program have been analysed – homosexual men, injecting drug users, the heterosexual population, and clients of commercial sex workers. The analysis of the effectiveness of the Program in each of these populations indicates that the Program has been highly successful, and has contributed significantly to:

- A reduction in the number of cases of HIV avoided (45,000 cases avoided);
- A reduction in the number of deaths from HIV (2,750 deaths avoided by 2010);
- Avoidance of significant clinical care costs of HIV and AIDS over the lifetime of the cases avoided (estimated at $18,000 million, undiscounted);
- A positive Net Present Value in respect of the investment in preventative initiatives and the clinical care costs avoided;
- An increase in life years survived by persons who would otherwise have contracted HIV (394,000 life years saved); and
- An improvement in the quality of life among persons who would otherwise have contracted HIV (863,000 QALYs saved).

The analysis also indicates that continued investment in the preventative initiatives of the Program can be expected to continue to provide benefits in each of these areas into the future.

The model used in this study has relied on a range of data, with estimates and assumptions made where data were not available or limited. The results indicate that no reasonable changes to the underlying assumptions or estimates used are likely to materially affect the results achieved. Nevertheless, improved data collections across a number of areas, particularly monitoring of funds invested across priority population groups, would further enhance the reliability of the results and support the application of the model to other priority populations.

1

INTRODUCTION

1.1 BACKGROUND

Human immunodeficiency virus (HIV), the virus that causes acquired immune deficiency syndrome (AIDS), was first diagnosed in New South Wales (NSW) in the early 1980s. Since then, it has had a significant effect on public health, causing over 3,600 deaths from AIDS (NCHECR 2006). By the end of 2005, NSW had a total of over 14,000 reported HIV cases, 92% of whom were males, and 5,600 AIDS cases (NCHECR 2006).

Within Australia, approximately 57% of total HIV diagnoses have been reported in NSW since 1996 (ABS 2006). Over the past five years, rates of diagnosis of AIDS and HIV infection were highest in NSW at 1.5 and 5.9 per 100,000 population, respectively (NCHECR 2006). The population rate of diagnosis of newly acquired HIV infection was relatively stable in NSW between 1996-2000, but in the past five years the rate of diagnosed newly acquired HIV infection increased by 20%. These reported diagnoses of newly acquired HIV infection are considered to represent a lower limit to the number of cases of HIV transmission that have actually occurred.

Response to the HIV epidemic was initiated in 1983 with the formation of the AIDS Action Committee, which later became the AIDS Council of NSW in 1985. In 1983, the NSW government formed a consultative committee on AIDS, which included representatives from clinicians, researchers and the gay community. The National Health and Medical Research Council (NHMRC) also established its first working group on AIDS in 1983 (Stewart and Penny 2003). Responsibility for the implementation of HIV/AIDS programs in NSW and services is now shared between Area Health Services and non-government organisations. In addition, a range of other government agencies, including Housing and Disability, Ageing and Home Care provide services to people living with HIV/AIDS with specific needs.

There has been a marked shift in the burden of disease associated with HIV/AIDS since highly active antiretroviral treatments (HAART) became available in Australia in 1996. At a population level, HAART has led to a significant decline in mortality arising from HIV/AIDS, with a concomitant increase in life span, and disability-adjusted life years.

The changes in mortality and morbidity associated with HIV/AIDS have created new challenges for the HIV/AIDS program. This study has reviewed the outcomes arising from the NSW investment in HIV prevention, care, clinical care and support, and identified emerging challenges.

This report provides an overview of the historical impact of the HIV/AIDS epidemic in NSW and projects the future impact of HIV/AIDS in NSW. This encompasses the economic impact of the epidemic in regard to clinical care costs avoided, the investment in the public health response to HIV/AIDS and the morbidity and mortality arising from HIV/AIDS. Where feasible, comparisons are also provided with investments in other public health programs.

1.2 THE NSW HIV/AIDS PROGRAM

The NSW HIV/AIDS Program was established in 1984 and encompasses research, primary and secondary prevention, and care, treatment and support for people living with HIV/AIDS. The NSW HIV/AIDS Strategy articulates the framework for collaboration between government, affected

communities, researchers and medicine, and seeks to ensure that programs and services are informed by both the best available evidence and the experience of those living with or at risk of HIV infection. Strengthening the partnership is an ongoing priority for the NSW response to HIV/AIDS.

The Program is predominantly funded by the NSW State Government, with some contribution from the Australian Federal Government through the Public Health Outcomes Funding Agreement. There are also in-kind and financial contributions by NSW Area health Services Funding. Funding is provided to Area Health Services and NGOs to provide specific programs and services that meet identified outcomes.

The Program identifies priorities for reducing future infections among those populations considered at highest risk: gay men, people from culturally and linguistically diverse (CALD) backgrounds, Aboriginal people, people who inject drugs, and sex workers. It also identifies priorities for improving the health of people living with HIV/AIDS, through both population-level programs, individual clinical services, research and service development.

The Program also provides a framework for ensuring that funding and service delivery infrastructure is allocated in line with the current needs of members of priority populations. Within NSW, significant reorientation initiatives have been undertaken to review the service needs of these populations and improve alignment of resources to those needs. This includes ensuring that workforce development, research, and state-wide service infrastructure supports best practice health promotion, and treatment, care and support service delivery.

1.3 OBJECTIVES OF THE STUDY

The intention of this study is to examine the costs and benefits arising from the NSW response to HIV/AIDS and to comment on future strategies to maximise the health and economic impact of the program. In particular, the primary objectives of this project are to determine:

- Projections of HIV incidence and prevalence in NSW in the coming decade, including anticipated impact of HIV/AIDS across priority populations;
- The direct costs of HIV/AIDS to the NSW health system, including lifetime clinical care costs;
- The total direct costs of HIV/AIDS in NSW, including all government, out of pocket and other private expenses;
- The indirect costs of HIV/AIDS in NSW, including quality of life effects and decreased productivity;
- The cost per person diagnosed with HIV/AIDS, including direct and indirect costs;
- Analysis of the health gain arising from the public health response to HIV/AIDS in NSW, with regard to infections averted and improved health outcomes for people living with HIV/AIDS;
- Analysis of the economic benefits or savings to government arising from the NSW public health response to HIV/AIDS;
- Analysis of the net benefits and cost-effectiveness of the public health response to HIV/AIDS in NSW, including the cost per unit health gain;
- Assessment of the effectiveness of the NSW HIV/AIDS programs against comparable HIV/AIDS and population health programs; and
- Recommendations regarding the future development of the NSW HIV/AIDS program in order to maximise effectiveness and value for money.

For all analyses and models, the HIV epidemic in NSW was divided into the following four exposure categories:

- Male homosexual contact;
- Injecting drug use;

- Heterosexual contact; and
- Heterosexual contact through commercial sex.

These groups were among the priority populations identified for the Program, as were Indigenous and CALD populations. However, data on transmission rates for the latter groups were considered to be inadequate to support the projections required for this study. Further research and data collection is required for these groups to support a similar analysis in the future.

1.4 METHODOLOGY

The methodology employed for this study comprised two discrete stages:

The first stage was an epidemiological study undertaken by the National Centre for HIV Epidemiology and Clinical Research (NCHECR) that had the following objectives:

- Briefly summarise available epidemiological and behavioural data on the HIV epidemic in NSW;
- Develop mathematical transmission and natural history models of the HIV epidemic in NSW that estimate HIV incidence, and numbers of people living with HIV by disease stage, over the period 1980 to 2005;
- Use the mathematical models to estimate HIV incidence and numbers of people living with HIV over the period 1980 to 2005 in the absence of NSW intervention strategies; and
- Use the mathematical models to project HIV incidence in NSW over the period 2006-2016, assuming that NSW intervention strategies continue, and that they are ceased.

The second stage, undertaken by Health Outcomes International Pty Ltd (HOI) was an analysis of the economic and related impacts of the Program. These included:

- Identification and analysis of the funds expended under the NSW HIV/AIDS Program from its inception to 2005;
- Identification of the direct costs of clinical care for HIV/AIDS for affected persons;
- Identification of the impacts of HIV/AIDS on quality of life for affected persons, in terms of Quality-Adjusted Life Years (QALYs); and
- Application of these data to the projections prepared by NCHECR in the previous component of the study in an economic model to illustrate the economic impact of the Program in terms of clinical care costs avoided and life years and QALYs saved.

1.5 STRUCTURE OF THE REPORT

The report comprises the following Chapters:

Executive Summary

Chapter 1: Introduction.

Chapter 2: Epidemiological Analysis.

Chapter 3: Economic Analysis.

Chapter 4: Discussion and Conclusions.

Appendix A: References.

Appendix B: Modelled HIV incidence and prevalence, baseline scenario, 1980-2005.

Appendix C: Modelled HIV incidence and prevalence, alternative (no intervention) scenario, 1980-2005.

Appendix D: Modelled HIV incidence and prevalence, baseline scenario, 2006-2016.

Appendix E: Modelled HIV incidence and prevalence, alternative (terminated intervention) scenario, 2006-2016.

2

EPIDEMIOLOGICAL ANALYSIS

2.1 OBJECTIVES

The objectives of this section of this report are to:

- Briefly summarise available epidemiological and behavioural data on the HIV epidemic in NSW.
- Develop mathematical transmission and natural history models of the HIV epidemic in NSW that estimate HIV incidence, and numbers of people living with HIV by disease stage, over the period 1980 to 2005.
- Estimate HIV incidence and numbers of people living with HIV over the period 1980 to 2005 in the absence of NSW intervention strategies.
- Project HIV incidence in NSW over the period 2006-2016, assuming that NSW intervention strategies continue, and that they are ceased.

2.2 EPIDEMIOLOGICAL DATA

2.2.1 SURVEILLANCE

The principal epidemiological surveillance data in NSW available since the beginning of the HIV/AIDS epidemic are newly-diagnosed HIV infections, AIDS diagnoses and survival following AIDS.

In NSW, HIV reference pathology laboratories confirm newly diagnosed HIV infections and notify positive clinical specimens. Under the NSW Public Health Act 1991, all HIV reference pathology laboratories in NSW are required to notify the NSW Department of Health of persons newly diagnosed with HIV infection. A nationally standardised case definition is applied. Laboratories send a standard notification form with the HIV positive result to the treating medical practitioner, seeking detailed demographic information about the case and information about clinical history, health status and HIV risk exposure. This information is forwarded to the NSW Department of Health and entered on a secure database, the NSW HIV/AIDS Database (Tuck, Habib et al. 2005).

Trends in numbers of new HIV diagnoses are not necessarily a good measure of HIV incidence since people can be infected with HIV for a number of years before they are tested and diagnosed. To try to monitor trends in HIV incidence with greater sensitivity, a subset of newly diagnosed HIV infections that have evidence that the infection was recently acquired are also reported separately. These newly acquired HIV infections are formally defined as newly-diagnosed HIV infections with either a previous HIV-negative test within the previous 12 months or with evidence of recent seroconversion illness. While trends in newly acquired HIV infections are an incomplete measure of HIV incidence, the numbers do put a lower limit on HIV incidence rates, and in addition, if patterns of testing remain stable, may capture increases or decreases in true HIV incidence rates.

AIDS is a notifiable condition in NSW, with cases notified by the diagnosing doctor to the NSW Health Department. AIDS is defined according to the US Centers for Disease Control and

Prevention AIDS surveillance definition, with the addition from 1993 of recurrent pneumonia, pulmonary tuberculosis and cervical cancer. At AIDS diagnosis, information is sought on sex, date of birth, CD4+ cell count at diagnosis, date of first HIV diagnosis and source of exposure to HIV.

Indigenous status of HIV and AIDS diagnoses has been collected prospectively in NSW only since 1992, and ethnicity (country of birth) since 2002 and 1984 for HIV and AIDS respectively. Data are also available, through enhanced surveillance of heterosexually acquired HIV diagnosis, on HIV diagnoses in people from high prevalence countries.

One limitation of these surveillance data are that they are relatively insensitive to HIV infections transmitted through female sex work. These would only be detected if an HIV or AIDS diagnosis was reported with a source of HIV infection ascribed to female sex work. However, there is no category for HIV transmission either to or from female sex workers on the standard notification form and it may well be that such HIV cases would simply be reported as heterosexual contact. Whilst there is also enhanced surveillance of HIV diagnoses reported to be through heterosexual contact that might capture information about transmission to or from female sex workers, to the end of 2005 there have been no reported cases of HIV or AIDS with source of exposure ascribed to female sex work.

2.2.2 NEWLY-DIAGNOSED HIV INFECTIONS

In NSW the number of people with a newly diagnosed HIV infection peaked in 1987, and then continued to decrease throughout the 1990s to 2001. However, since 2002 the number increased slightly, with most of these cases reported in males aged between 25 and 49 years who lived in metropolitan Sydney (Tuck, Habib et al. 2005). The proportion of new HIV diagnoses in females fluctuated between 6 and 10 percent over the period 1994-2003.

HIV notifications declined to a nadir in 2001. HIV incidence subsequently increased to 2003 and has effectively plateaued since then. Approximately 65% of people with HIV reported primary exposure through male-to-male sexual contact. Table 1 gives the estimated number of cases of newly diagnosed HIV infections in NSW between 1981and 2005.

Table 1: Estimated number of cases of newly diagnosed HIV infection adjusted for multiple reporting, by year and exposure category, NSW 1981-2005.

Year	HIV exposure category						Total
	Male homo-/bi-sexual contact	Male homo-/bi-sexual contact and injecting drug use	Injecting drug use	Heterosexual contact	Healthcare setting	Other/undetermined	
1981	0	0	0	0	0	1	1
1982	0	0	0	0	1	0	1
1983	0	2	0	0	0	0	2
1984	137	1	0	1	19	49	207
1985	554	17	12	7	84	348	1,022
1986	547	19	33	9	47	455	1,110
1987	745	31	31	16	27	501	1,352
1988	687	17	49	32	25	254	1,064
1989	549	26	37	36	9	280	937
1990	499	18	46	45	10	268	885

Year	HIV exposure category						Total
	Male homo-/bi-sexual contact	Male homo-/bi-sexual contact and injecting drug use	Injecting drug use	Heterosexual contact	Healthcare setting	Other/undetermined	
1991	526	25	37	55	13	226	881
1992	462	20	29	43	7	104	665
1993	422	18	14	42	2	77	576
1994	361	29	18	49	6	47	509
1995	364	27	18	49	3	62	523
1996	279	16	13	35	2	83	428
1997	248	15	8	33	0	67	370
1998	238	17	8	49	3	74	389
1999	244	16	13	43	0	52	368
2000	226	11	12	39	0	62	349
2001	213	18	18	31	0	58	338
2002	251	13	10	33	0	86	393
2003	276	8	11	38	0	60	393
2004	252	9	14	39	0	82	397
2005	266	6	10	44	0	69	394
Total	**8,343**	**381**	**439**	**767**	**257**	**3,366**	**13,554**

Source: National Centre in HIV Epidemiology and Clinical Research

More than half of the people notified as infected with HIV were reported to reside in metropolitan Sydney, principally within inner Sydney, at the time of their HIV diagnosis. However, increasing numbers of HIV notifications have been reported since 2001 in residents of Illawarra and Hunter area health services at the time of diagnosis.

2.2.3 NEWLY-ACQUIRED HIV DIAGNOSES

Table 2 shows the number of diagnoses of newly-acquired HIV infections, defined as new HIV diagnoses with either a previous HIV-negative test within the previous 12 months or with evidence of recent seroconversion, in NSW between 1981 and 2005. More active national surveillance of newly-acquired HIV infections began in 1993. There was some decline in newly-acquired HIV in NSW in the mid-1990s, concurrent with the availability of combination antiretroviral treatment which, through decreased HIV viral load in treated patients, might result in decreased infectiousness and reduced HIV transmission. However, there was some evidence of a subsequent increase in numbers of newly acquired HIV diagnoses in the period 2001 to 2003. Newly-acquired HIV diagnoses appeared to stabilise in 2004 and 2005, albeit at somewhat higher levels than in the late 1990s.

Newly acquired HIV diagnoses appear to make up a slightly greater proportion of all HIV diagnoses (refer Table 1) in the mid-2000s (when approximately 33% of all HIV diagnoses were newly acquired) compared with 1996 to 1999 (approximately 21%). Whether this merely reflects changes in patterns of HIV testing, or changes in underlying patterns of HIV incidence is not clear.

Table 2: Diagnoses of newly-acquired HIV infections, by year and HIV exposure category, NSW 1981-2005.

Year	HIV exposure category						Total
	Male homo-/bi-sexual contact	Male homo-/bi-sexual contact and injecting drug use	Injecting drug use	Heterosexual contact	Healthcare setting	Other/undetermined	
1981	0	0	0	0	0	1	1
1982	0	0	0	0	0	0	0
1983	0	0	0	0	0	0	0
1984	12	0	0	0	0	2	14
1985	42	1	1	0	0	6	49
1986	30	1	2	2	0	1	30
1987	16	1	0	1	0	0	18
1988	19	1	1	1	0	0	22
1989	11	0	1	2	0	1	15
1990	15	0	0	1	1	1	18
1991	18	4	1	3	0	1	27
1992	81	7	5	3	1	1	98
1993	121	3	4	9	0	4	142
1994	94	9	2	9	1	2	117
1995	110	5	1	8	0	1	126
1996	75	6	0	4	0	0	85
1997	60	4	1	4	0	0	70
1998	65	5	0	1	0	0	71
1999	74	8	3	7	0	2	94
2000	76	3	1	4	0	2	86
2001	75	8	3	11	0	5	102
2002	107	4	0	3	0	5	120
2003	140	3	2	8	0	2	156
2004	98	3	3	6	0	7	117
2005	108	2	0	7	0	8	125
Total	**1,447**	**78**	**31**	**94**	**3**	**52**	**1,705**

Source: National Centre in HIV Epidemiology and Clinical Research

2.2.4 NEWLY-DIAGNOSED AIDS CASES

AIDS diagnoses and deaths following AIDS, in NSW between 1981 and 2005 are summarised in Tables 3 and 4 respectively. Both AIDS diagnoses and deaths peaked in 1994 in NSW, with large declines in AIDS diagnoses and deaths from 1996 onwards with the availability of very effective combination antiretroviral treatment. This pattern appeared consistent across most exposure categories, except AIDS diagnoses in people with HIV-infection through heterosexual contact. AIDS diagnoses in this group showed little decline through the late 1990s. It is thought this is due to late HIV-diagnosis in this group, i.e. diagnosis of HIV only at or close to the time of AIDS diagnosis.

Such late HIV diagnosis would preclude the benefit of antiretroviral treatment in this group in delaying AIDS. There is some evidence to support this theory in that deaths following AIDS in people whose source of HIV infections was heterosexual contact did indeed fall in line with other exposure routes from 1996 onwards (refer Table 4).

Table 3: Number of AIDS diagnoses, adjusted for reporting delay, by year and HIV exposure category, NSW 1981-2005.

Year	HIV exposure category						Total
	Male homo-/bi-sexual contact	Male homo-/bi-sexual contact and injecting drug use	Injecting drug use	Heterosexual contact	Healthcare setting	Other/undetermined	
1981	0	0	0	0	0	1	1
1982	1	0	0	0	0	0	1
1983	1	0	0	0	0	0	3
1984	22	0	0	0	7	0	30
1985	74	1	1	0	14	2	92
1986	141	1	2	0	11	2	162
1987	220	0	1	1	20	3	252
1988	284	1	3	5	11	5	320
1989	308	9	10	5	13	8	357
1990	365	3	8	8	17	13	422
1991	366	8	16	16	16	14	442
1992	352	4	9	24	16	10	429
1993	394	8	12	23	9	17	482
1994	454	13	20	18	13	22	549
1995	385	7	10	24	11	20	478
1996	290	6	10	25	6	25	371
1997	157	7	10	21	3	11	207
1998	122	9	12	26	3	7	175
1999	79	4	7	26	1	3	123
2000	80	7	9	23	3	7	128
2001	72	1	3	12	1	4	96
2002	74	3	4	17	0	4	105
2003	105	9	10	21	0	6	157
2004	73	6	6	21	1	3	111
2005	67	7	9	19	1	3	108
Total	**4,486**	**114**	**172**	**335**	**177**	**190**	**5,601**

Source: National Centre in HIV Epidemiology and Clinical Research

While deaths following AIDS have declined since 1996 in all exposure categories, it does appear that numbers of deaths have remained reasonably constant since 1999. Data from the Australian HIV Observational Database suggests that mortality rates in people with HIV infection remain

possible as much as 10-fold higher than age and sex matched population rates. (Ref Petoumenos K, Law MG. Sexual Health 2006;3:103-112).

Table 4: Number of deaths following AIDS, adjusted for reporting delay, by year and HIV exposure category, NSW 1981-2005.

Year	HIV exposure category						Total
	Male homo-/bi-sexual contact	Male homo-/bi-sexual contact and injecting drug use	Injecting drug use	Heterosexual contact	Healthcare setting	Other/undetermined	
1981	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0
1983	1	0	0	0	0	0	1
1984	2	0	0	0	2	0	6
1985	35	0	0	0	9	1	46
1986	90	0	0	0	14	3	109
1987	122	1	2	0	12	3	143
1988	127	0	0	1	7	1	141
1989	214	1	1	3	12	4	238
1990	283	5	9	3	10	9	324
1991	293	4	5	9	17	7	344
1992	285	3	8	10	16	9	333
1993	316	5	10	15	8	8	375
1994	338	6	10	21	13	16	419
1995	283	8	14	12	14	16	355
1996	216	8	9	15	3	14	268
1997	99	1	4	4	4	7	124
1998	57	4	4	3	0	4	72
1999	53	3	3	4	3	3	68
2000	61	3	4	8	2	2	81
2001	47	2	2	4	3	1	62
2002	37	1	5	5	0	2	53
2003	38	3	4	5	0	1	54
2004	40	3	3	3	2	2	58
2005	23	4	7	2	1	2	36
Total	**3,060**	**65**	**104**	**127**	**152**	**115**	**3,710**

Source: National Centre in HIV Epidemiology and Clinical Research

2.3 BEHAVIOURAL DATA

2.3.1 HOMOSEXUAL MEN

HIV among homosexual men is largely transmitted through unprotected anal intercourse (UAI). The key behaviour change among homosexual men in response to the HIV/AIDS epidemic in the early 1980s was the adoption of safe sex, principally through the use of condoms. In the 1970s, before the start of the HIV epidemic, condoms were virtually never used in anal sex among homosexual men. Data on levels of condom use among the male homosexual population since the epidemic were obtained from a range of studies conducted in NSW, summarised in Table 5.

Table 5: Summary of studies conducted involving the homosexual population in New South Wales.

Study	Summary	Reference
SAPS – Sydney AIDS Prospective Study	1984-1988: A clinic-based cohort study of over 1,000 men in Sydney. Questions on condom use were not asked until 1987 and did not distinguish between casual and regular partners.	(Tindall, Cooper et al. 1988)
SAPA – Social Aspects of the Prevention of AIDS	1986-1987: A convenience sample of 535 men in NSW, mainly Sydney, recruited through gay networks.	(Connell, Crawford et al. 1989)
SSS – Sustaining Safe Sex	1991: A follow-up study of 145 SAPA participants.	(Kippax, Dowsett et al. 1993)
MC – Project Male Call	1992 & 1996: An anonymous telephone survey of 828 respondents.	(NCHSR 1998)
MO – Project Male Out	2000: NSW respondents to anonymous reply-paid mail survey of nearly 2,000 homosexual men who subscribe to video and pornographic catalogues.	(Van de Ven, Rawstone et al. 2002)
SMASH – Sydney Men and Sexual Health	1993-1997: A cohort of HIV-negative and HIV-positive men interviewed annually. Convenience sample recruited through gay community sites.	(Van de Ven, Campbell et al. 1998)
GCPS – The Sydney Gay Community Periodic Survey	1996-2005: Involves a convenience sample of men recruited from gay community venues, clinics and events, using anonymous self-complete survey, twice a year. About 3,000 men complete surveys each year.	(NCHSR 2003)
pH – Positive Health	1998-2005: A cohort of HIV-positive men interviewed about a number of issues and behaviours including sex behaviour, almost annually from 2001. A convenience sample recruited through gay community sites.	(NCHSR 2003)
HIV – Health in Men	2001-2005: A cohort of HIV-negative men interviewed annually. A convenience sample recruited through gay community sites.	(Prestage, Van de Ven et al. 2005)

Percentages of homosexual men reporting unprotected anal intercourse (UAI) with regular and casual partners are shown in Figures 1 and 2 respectively. Data are limited, but UAI in both regular and casual partners appears to have reached high levels by mid-1980s and remained stable thereafter until the mid-1990s. There appears to be a slight increase in UAI with regular partners from 1995 onwards, and a more pronounced increase among casual relationships. In regular partnerships, negotiated safety agreements (whereby the partners adopt low-risk sex behaviours that don't require the use of condoms but limit the risk of HIV transmission) could reduce the apparent risk levels of UAI in regular partnerships. Among casual partnerships there is possibly a higher likelihood of having UAI with partners of HIV-positive or unknown serostatus (Dawson, Fitzpatrick et al. 1994; Crawford, Rodden et al. 2001). An upward trend in occasions of UAI among gay men since 1996 was observed, although UAI rates appear to have now plateaued.

Figure 1: Homosexual men reporting any unprotected anal intercourse with a regular partner (UAIR), 1986–2005.

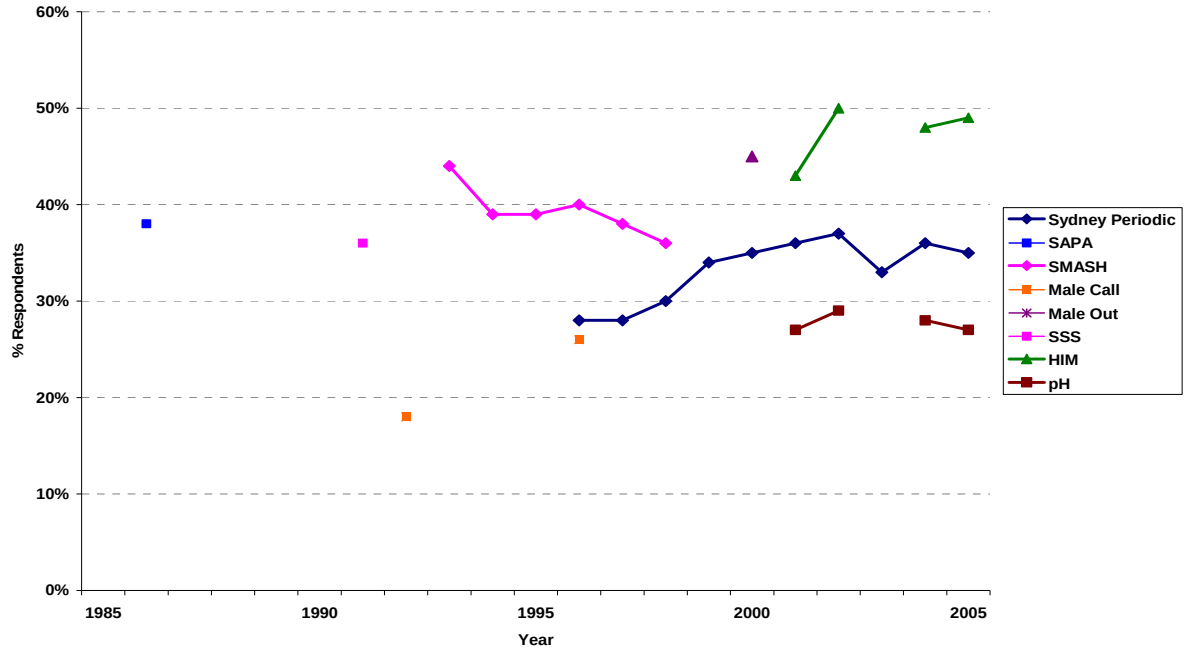
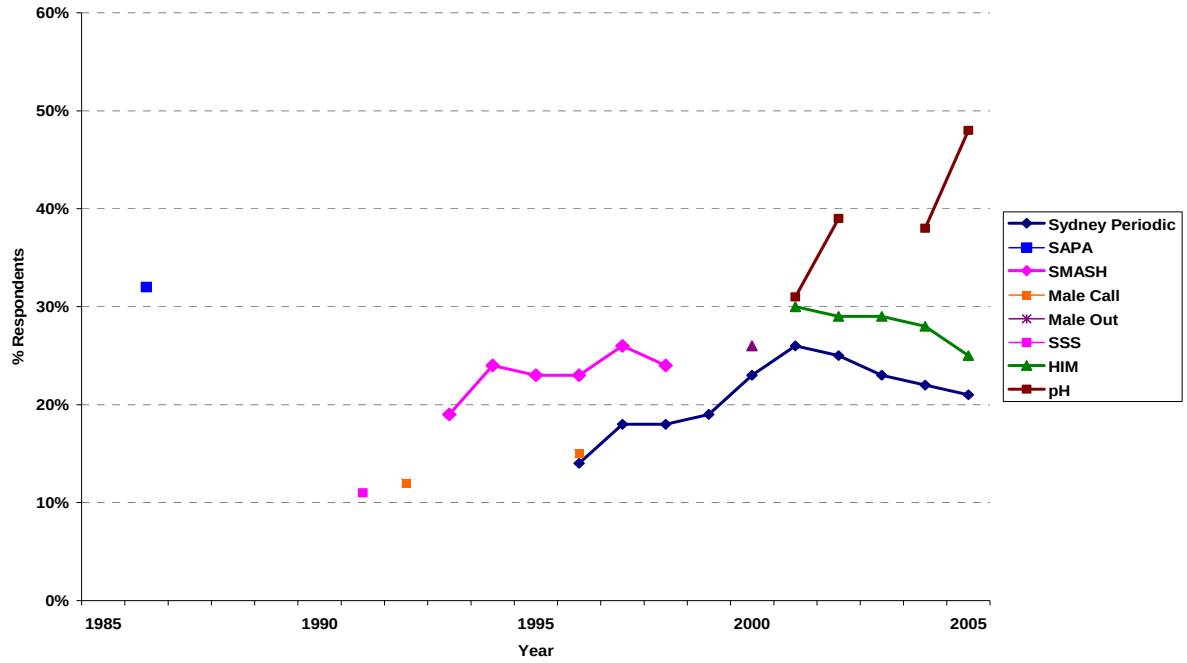
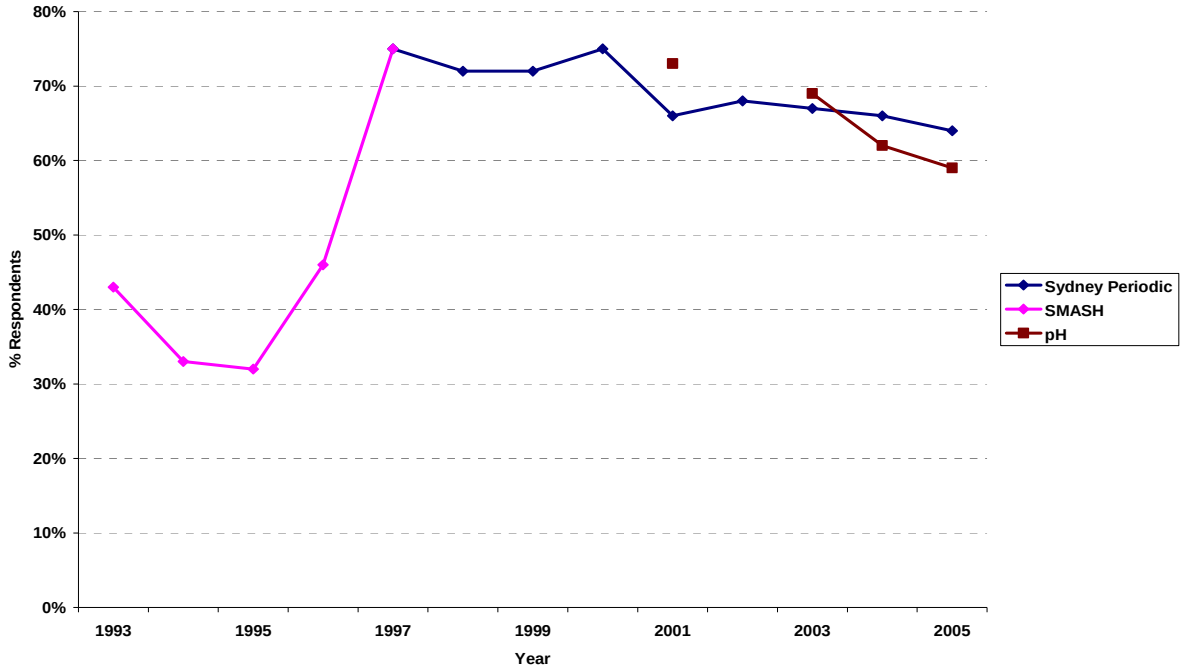


Figure 2: Homosexual men reporting any unprotected anal intercourse with a casual partner (UAIC), 1986–2005.



As well as the clear benefits in terms of reduced mortality and morbidity attributable to ARV therapy, it may also contribute to decreases in HIV transmission through decreased HIV viral load in patients receiving therapy and hence reduced infectiousness. Figure 3 shows the levels of ARV therapy coverage reported in behavioural studies among homosexual men since 1993. Prior to the availability of combination ARV in 1996, treatment was predominantly monotherapy, with 1995 being a transition year. These data suggest a rapid increase in ARV uptake in 1996, with a plateau at around 70% of HIV positive men receiving ARVs. This rapid uptake in ARV in 1996 reflects NSW Health investment in clinical care supporting access to treatment. In the early 2000s there is possibly a trend to decreased use of ARVs, reflecting changes in prescribing practices to a more conservative use of ARVs. Similar trends in ARV uptake have been reported in the Australian HIV Observational Database (NCHECR 2006).

Figure 3: Homosexual men reporting use of any antiretroviral therapy, 1993–2005.



2.3.2 INJECTING DRUG USERS

The estimated total number of injecting drug users (IDUs) in Australia in 2005 was around 215,000, which was a decline from the peak of 321,000 in 1999 (HCVPWG 2006). Of these, 47% (101,000 in 2005) were estimated to be IDUs in NSW, based on indicators of opioid overdose deaths in Australia between 1988 to 2003 (NDARC 2003).

Among IDUs, a very low proportion of those who report no male homosexual contact are infected (Kaldor, Elford et al. 1993), with very low HIV and AIDS diagnoses attributed to HIV transmission through injecting drug use. This limited HIV epidemic among IDUs has been attributed to the existence of relatively small drug injecting networks at the start of the epidemic as well as the implementation of community-based education programs, the early institution of government-funded needle and syringe programs, and improved access to methadone through public clinics and private doctors (Donovan, Minichiello et al. 1998). In particular, provision of clean injecting equipment through needle and syringe programs may have reduced rates of sharing, and hence reduced transmission.

NEEDLE AND SYRINGE PROGRAMS

Needle and Syringe Programs (NSPs) are a public health measure to reduce the spread of blood-borne viral infections such as HIV and hepatitis C among IDUs. These programs are supported by the National Drug Strategy's harm reduction framework. They provide a range of services that include provision of injecting equipment, education and information on reduction of drug-related harms, referral to drug treatment, medical care, and legal and social services. Equipment provided includes needles and syringes, swabs, vials of sterile water and 'sharps bins' for the safe disposal of used injecting equipment. The aim of providing sterile injecting equipment is to prevent the shared use of injecting equipment, which can lead to transmission of blood-borne viral infections. Staff also address the potential for transmission of infection via sexual contact by providing condoms and safer sex education. By engaging IDUs in health services, those who continue to use drugs are less likely to incur harm to themselves and to the society (HOI, NCHECR et al. 2002).

The first Australian NSP began in Sydney in 1986 as a trial project to contain the spread of HIV within the drug injecting communities. The testing of syringes returned to this Darlinghurst program detected an increase in HIV prevalence, suggesting that HIV was spreading among clients. In the following year NSPs became NSW government policy.

Table 6 gives a summary of needle and syringe distribution units (units of injecting equipment) through the NSW NSP from the second half of 1999 up to the first half of 2005. During this time period, a total of over 61 million units of sterile injecting equipment were distributed, which peaked in 2000 and has been declining since then (HCVPWG 2006).

Table 6: Summary of needle and syringe distribution units (units of injecting equipment) through the NSW Needle and Syringe Program.

Year	Quarter	Units of injecting equipment distributed		
		Public	Pharmacy	Total
1999	Jul-Sep	1,775,163	916,106	2,691,269
	Oct-Dec	1,917,836	930,853	2,848,689
2000	Jan-Mar	2,033,086	891,127	2,924,213
	Apr-Jun	1,966,888	1,085,604	3,052,492
	Jul-Sep	2,079,927	1,251,046	3,330,973
	Oct-Dec	2,090,667	1,169,732	3,260,399
2001	Jan-Mar	2,033,577	958,674	2,992,251
	Apr-Jun	1,964,034	886,748	2,850,782
	Jul-Sep	1,973,273	819,807	2,793,080
	Oct-Dec	1,802,660	912,164	2,714,824
2002	Jan-Mar	1,684,320	759,180	2,443,500
	Apr-Jun	1,622,248	769,348	2,391,596
	Jul-Sep	1,592,408	691,200	2,283,608
	Oct-Dec	1,660,980	673,860	2,334,840
2003	Jan-Mar	1,712,307	581,200	2,293,507
	Apr-Jun	1,604,576	599,000	2,203,576
	Jul-Sep	1,581,899	637,100	2,218,999
	Oct-Dec	1,682,679	631,500	2,314,179
2004	Jan-Mar	1,655,671	635,000	2,290,671
	Apr-Jun	1,571,921	605,600	2,177,521
	Jul-Sep	1,660,655	644,900	2,305,555
	Oct-Dec	1,710,323	616,600	2,326,923
2005	Jan-Mar	1,614,435	550,300	2,164,735
	Apr-Jun	1,551,619	566,700	2,118,319
Total		**42,543,152**	**18,783,349**	**61,326,501**

Source: NSW Health Department

2.3.3 GENERAL HETEROSEXUAL POPULATIONS

The impact of the HIV epidemic on the 'general' heterosexual population was minimised by the relative rarity of HIV in 'transitional' populations such as IDUs and female commercial sex workers (CSWs) (Donovan, Minichiello et al. 1998).

In the Australian Study of Health and Relationships conducted in 2001-2002, 59% of heterosexuals who had casual partners reported unprotected sex which translates to 3.3% of heterosexually

active people (de Visser, Smith et al. 2003). Among those who reported casual partners, unprotected sex was more common in heterosexual activity than in male homosexual activity. Condoms were used in 20% of the most recent episodes of vaginal intercourse. The rate of use is generally associated with partner type and use of other contraceptions, suggesting that condoms are largely used for contraceptive purposes. In the six months prior to the survey, only 7.1% reported always used condoms with a regular live-in partner, 22.5% with a regular partner who did not live together, and 41.4% always used condoms with casual partners (de Visser, Smith et al. 2003).

2.3.4 COMMERCIAL FEMALE SEX WORKERS

In the late 1970s, there was a virtual absence of any community organisation, or peer education and support for commercial sex workers (CSWs). Condoms were rarely used in brothels (<1% of sexual contacts). Incidence rates of sexually transmitted infections such as gonorrhoea were as would have been expected in developing countries. At the population level, bacterial STIs were about ten times more common in Australia at the beginning of the 1980s than they were by mid 1990s (Donovan and Harcourt 1996).

High rates of compliance of safe sex practices were reported by the end of the 1980s among urban brothel-based male and female sex workers. The improvements have been attributed to law reform, fear of HIV/AIDS, the formation of sex worker organisation, peer education and health service development including condom distribution.

In the mid 1990s, HIV remained rare within the female sex industry in Australia (Donovan and Harcourt 1996). In a study of street sex workers in 1997, it was found that HIV prevalence was 2.1% among the street CSWs interviewed (one CSW who was also an IDU), 1.8% in a Kirketon Road Centre (KRC) sample (two out of 122), and 0.3% among CSWs attending the Sydney Sexual Health Centre (SSHC, two out of 674), (Harcourt, van Beek et al. 2001). In another study, four out of 1,112 CSWs tested in Sydney were HIV-positive (0.4%), (Escourt, Marks et al. 2000).

A survey of 1,671 FSWs in Sydney estimated that the FSWs have a median number of 20 clients per week (range 1-120), (Escourt, Marks et al. 2000). Reported condom use among resident CSWs was over 95% of commercial encounters. A study showed that in 1997, the Sydney Sexual Health Centre (SSHC) showed higher condom use rate among local sex workers (98.8%) compared to non-resident 'international' sex workers (80.4%), who make up 10% of the industry in Sydney (Donovan and Harcourt 1996; Harcourt, van Beek et al. 2001). Consistent condom use was lower and IDU rates higher among street-based sex workers when compared to their local brothel-based counterparts. The study also showed that among a KRC street sex worker sample, 66.8% of the sex workers were current IDUs.

2.3.5 ANTIRETROVIRAL THERAPIES

Since 1996, the introduction of highly active antiretroviral therapy (HAART) has contributed to reducing HIV morbidity and increasing disability-adjusted life-years, delaying progression to AIDS and improved survival following AIDS (Tuck, Habib et al. 2005). HAART may also contribute to decreases in HIV transmission through decreased HIV viral load in patients receiving therapy and hence reduced infectiousness. There has been a shift in the burden of disease associated with HIV/AIDS since HAART became available. An estimated 70% of all people diagnosed with HIV infection were receiving antiretroviral (ARV) treatment in 2005 (NCHECR 2006). Table 7 shows the uptake of ARV treatment for HIV infection among people from NSW enrolled in the Australian HIV Observational Database in 2005. In particular, although these data are limited, they suggest that ARV uptake is similar in other HIV-exposure categories to male homosexual men. They also suggest that ARV treatment is more common with more advanced HIV disease, be that lower CD4 count or previous diagnosis of an AIDS defining illness.

Table 7: Antiretroviral treatment among people from NSW enrolled in the Australian HIV Observational Database in 2005.

	ARV treatment					
	None	Mono/ Double	3+ (NRTI +/- PI, no NNRTI)	3+ (NRTI +/- NNRTI, no PI)	3+ (NNRTI +/- PI, no NRTI)	Total
Total	**109 *(19)***	**39 *(7)***	**174 *(32)***	**173 *(32)***	**55 *(10)***	**545**
Sex						
Male	101 *(19)*	36 *(7)*	166 *(32)*	168 *(32)*	55 *(10)*	**526**
Female	3 *(16)*	3 *(16)*	8 *(42)*	5 *(25)*	0 *(0)*	**19**
Age at enrolment (years)						
Less than 30	8 *(24)*	2 *(6)*	9 *(26)*	14 *(41)*	1 *(3)*	**34**
30 – 39	56 *(28)*	16 *(8)*	59 *(29)*	61 *(30)*	11 *(5)*	**203**
40 – 49	31 *(14)*	14 *(7)*	70 *(33)*	70 *(33)*	30 *(14)*	**215**
50 +	9 *(10)*	7 *(8)*	36 *(39)*	28 *(30)*	13 *(14)*	**93**
Exposure category						
Male homosexual contact	87 *(18)*	33 *(7)*	151 *(32)*	154 *(33)*	48 *(10)*	**473**
Other/not reported	17 *(24)*	6 *(8)*	23 *(32)*	19 *(26)*	7 *(10)*	**72**
Viral load (copies/ml)						
<400	42 *(13)*	21 *(7)*	86 *(27)*	132 *(42)*	35 *(11)*	**316**
400 – 10,000	31 *(32)*	11 *(11)*	35 *(36)*	8 *(8)*	13 *(13)*	**98**
10,000 +	27 *(25)*	4 *(4)*	45 *(41)*	27 *(25)*	6 *(6)*	**109**
Not reported	4 *(18)*	3 *(14)*	8 *(36)*	6 *(27)*	1 *(5)*	**22**
CD4+ count (cells/µl)						
<200	5 *(9)*	6 *(10)*	27 *(47)*	13 *(22)*	7 *(12)*	**58**
200 – 500	38 *(17)*	15 *(7)*	80 *(36)*	68 *(30)*	24 *(11)*	**225**
500 +	60 *(24)*	18 *(7)*	58 *(23)*	88 *(35)*	24 *(10)*	**248**
Not reported	1 *(7)*	0 *(0)*	9 *(64)*	4 *(29)*	0 *(0)*	**14**
AIDS prior to enrolment						
No	98 *(24)*	27 *(7)*	118 *(29)*	128 *(32)*	32 *(8)*	**403**
Yes	6 *(4)*	12 *(8)*	56 *(39)*	45 *(32)*	23 *(16)*	**142**

Source: Australian HIV Observational Database

2.3.6 OTHER SEXUALLY-TRANSMITTED INFECTIONS

Sexually transmitted infections other than HIV, although transmitted in a number of ways, are of interest both as a broad marker of trends in unsafe sex, and as a co-factor that increases the risk of HIV transmission.

Reported gonorrhoea incidence rates in Australia declined markedly after the advent of HIV, although the epidemiological patterns remained more heterogenous than for syphilis. Much of the decline in gonorrhoea incidence rates in Australia's cities through the 1980s was attributable to behaviour change by homosexually active men. However, in the early 1990s, a slight resurgence in male, homosexually acquired gonorrhoea was observed (Donovan, Minichiello et

al. 1998). The rate of rectal gonococcal isolates among men in NSW also increased in the late 1990s, from 1.2 per 100,000 population in 1998 to 2.8 in 2000 and to 3.5 per 100,000 population in 2005 (NCHECR, 2006). Population rates of syphilis diagnoses also increased by 53% in NSW between 2001 and 2005, with these increases almost completely confined to homosexually active men (NCHECR, 2006).

In Sydney, by the end of the 1980s, more than half of the gonorrhoea diagnosed in heterosexual men attending a private clinic in Sydney was attributed to overseas acquisition. Declines in gonorrhoea among male patients at the SSHC were observed between 1980 and 1989. The decline was less impressive for female patients and there was a slight indication that there was an increase in the numbers of gonorrhoea cases in women from 1987. Overseas-born CSWs had 89% of all gonorrhoea diagnosed in women attending the SSHC in 1989 to 1990, although they accounted for only 17% of visits by female patients. Gonorrhoea prevalence of 17% among international CSWs attending SSHC for the first time contrasted with zero prevalence among local CSWs (Donovan, Minichiello et al. 1998). Condom use among sex workers in the mid 1990s translated into zero prevalence rates for gonococcal and chlamydial infections at first presentation at the SSHC.

2.4 MODELLING THE EPIDEMIOLOGY OF HIV IN NSW

2.4.1 APPROACH

For all analyses and models, the HIV epidemic in NSW was divided into the following four exposure categories:

- Male homosexual contact;
- Injecting drug use;
- Heterosexual contact; and
- Heterosexual contact through commercial sex.

To simplify the modelling, it was assumed that there was no overlap between the HIV epidemics in these four exposure categories. In particular, HIV in people who reported male homosexual contact and injecting drug use was included only in the male homosexual epidemic, and was assumed to be transmitted through male homosexual contact. Data limitations also meant that male homosexual commercial sex work was not modelled separately from all male homosexual contact.

Due to limited data, explicit modelling of epidemics by indigenous status or ethnicity was not attempted, although migrants from high HIV prevalence countries were included as a part of the modelling of heterosexual transmission. Furthermore, HIV transmission through routes other than the four above were not modelled and are not included.

The broad modelling strategy was as follows:

HIV transmission models were developed for male homosexual contact, heterosexual contact, and heterosexual contact through commercial sex. For male homosexual contact and heterosexual contact, these transmission models were calibrated to existing estimates of HIV incidence over the period 1980 to 2005, with the NSW HIV/AIDS Program in place. External estimates of HIV incidence through heterosexual contact with commercial sex workers were not available, and the estimates from the mathematical transmission models are simply presented. These HIV transmission models were then used to estimate HIV incidence in these exposure groups in the absence of the NSW HIV/AIDS Program.

HIV incidence in injecting drug users was also based on existing estimates of HIV incidence between 1980 and 2005, with the NSW HIV/AIDS Program. However, the effect of intervention strategies in IDUs, principally needle and syringe programs, on HIV incidence was estimated using previously used statistical models (HOI, NCHECR et al. 2002).

For all exposure groups, a model of HIV disease natural history was developed and used to estimate numbers of people living with HIV by disease stage.

For each of the exposure categories, the modelling of the estimates of HIV incidence and prevalence are presented in two main stages, comprising of scenarios set for estimating HIV incidence for 1980 – 2005 and 2006 – 2016.

- **Existing epidemic 1980–2005**: This stage estimates the effect of the NSW HIV/AIDS Program that was in place over this time period. HIV incidence was estimated under two scenarios:
    - The *current baseline epidemic scenario* which models HIV incidence with the main NSW HIV/AIDS Program in place since the beginning of the epidemic to 2005; and
    - A *no intervention scenario* which assumes that the NSW HIV/AIDS Program was not in place throughout the epidemic (other than antiretroviral therapy). HIV incidence and prevalence is estimated for 1980–2005, and the modelled estimates of total people living with HIV/AIDS in 2005 are then continued on until 2090, by which time all people living with HIV/AIDS are estimated to have died.
- **Projected epidemic 2006–2016**: This stage estimates what would happen to HIV incidence over the period if the NSW HIV/AIDS Program was either continued or stopped from 2007 onwards. Projections of the estimated incidence are modelled under two scenarios:
    - The *projected baseline epidemic scenario* which assumes the NSW HIV/AIDS Program will continue at the 2005 levels through 2006–2016; and
    - A *terminated intervention scenario* which assumes that the NSW HIV/AIDS Program is terminated from 2007 onwards. The HIV incidence and prevalence is estimated for 1980–2016, and the modelled estimates of total people living with HIV/AIDS in 2016 are then continued on until 2100, by which time all people living with HIV/AIDS are estimated to have died.

Intervention measures are reflected in the model in the levels of risk, either sexual contact rate (unsafe sex) or unsafe injecting. For the homosexual and heterosexual models, the risk behaviour intervention is based on condom/safe sex strategies, while in the injecting drug use model the risk behaviour intervention is tied to the Needle and Syringes Program. The impact of ARV is taken to be present in all modelled scenarios, although access and adherence to treatment relies crucially on the NSW investment in clinical care, including specialist medical services and pathology. This study therefore focuses on the modelled impacts of the preventative aspects of the Program rather than treatment.

In scenarios where it is assumed that NSW HIV/AIDS programs are absent, it is assumed that 50% of the estimated benefit in terms of changes in levels of sexual risk behaviour still occur without the intervention (NIMH 1998). This takes into consideration the natural population-driven change in risk behaviour independent of government funded intervention efforts. Lower and upper limits of the impact of intervention on changing risk levels are set at 25% and 75%, respectively.

2.4.2 ESTIMATES OF HIV INCIDENCE

External estimates of HIV incidence, by exposure category between 1981 and 2005 were based on a previous back-calculation estimates of HIV incidence in Australia (NCHECR 2000), combined with more recent transmission model estimates for male homosexual contact (Clements, Prestage et al. 2004). As noted previously, external estimates for heterosexual contact with commercial sex workers were not available. In the national back-calculation estimates, overall (all exposure categories) HIV incidence in NSW made up 55% of total incidence at the beginning of the epidemic in 1980, and peaked at 70% in 1983. The proportion then declined to 45% by 1998 and increased to reach a plateau of 60% by 1993 and onwards. This proportional change in HIV incidence in NSW based on national estimates is applied to all exposure categories.

A summary of the external estimated HIV incidence based on the national back-calculation estimates, by exposure category for NSW between 1980 and 1999 is shown in Table 8.

Table 8: Estimates of HIV incidence based on a back-calculation model, by exposure category, NSW 1980–1999.

Year	Estimated number of new HIV infections		
	Homosexual contact	Injecting drug use	Heterosexual contact (females)
1980	3	0	0
1981	53	1	1
1982	372	3	2
1983	1136	10	5
1984	1606	21	8
1985	1318	29	11
1986	857	35	13
1987	506	35	17
1988	314	31	24
1989	242	26	34
1990	232	22	45
1991	244	19	47
1992	244	16	36
1993	226	12	18
1994	226	12	18
1995	226	12	18
1996	226	12	18
1997	226	12	18
1998	226	12	18
1999	226	12	18

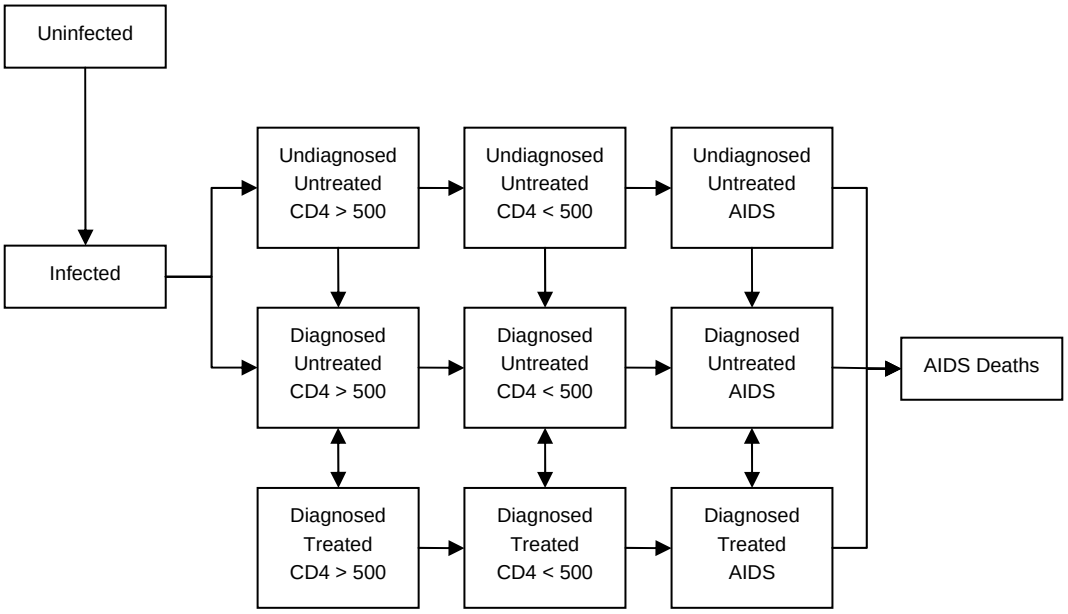
Source: National Centre in HIV Epidemiology and Clinical Research, 2000

2.4.3 HIV DISEASE NATURAL HISTORY MODEL

For all exposure categories, a model of HIV disease treatment and natural history was developed.

Figure 4 shows the compartmental model for the multi-state HIV infected population. Modelled estimates of the number of people living with HIV, by exposure category, are broken down by a 3 x 3 matrix of i) disease progression, categorised by CD4 cell counts of CD4 >500/μl, CD4 <500/μl and AIDS; and ii) diagnosis and treatment status as undiagnosed and untreated, diagnosed and untreated, and diagnosed and treated.

Figure 4: Multi-state model of HIV infection.



RATES OF HIV DISEASE PROGRESSION

The baseline rate of progression, i.e. without the uptake of HAART, from HIV seroconversion to AIDS is taken to correspond to a median time of 10 years and a progression rate of 11.2% (Alcabes, Munoz et al. 1993). Baseline rate of progression from seroconversion to a CD4+ cell count of less than 500/μl is assumed to be four years, with 95% below 500/μl by 10 years. The median survival following AIDS is taken to be 16 months.

NON-HIV MORTALITY RATES

Non-HIV related mortality was taken to be age-specific death rates obtained from the Australian Bureau of Statistics NSW life tables (ABS 2005).

In the IDU HIV prevalence models, drug-related death rates are incorporated by assuming that drug-related deaths among regular and occasional IDUs are 0.5% and 0.1%, respectively (HCVPWG 2006).

ANTIRETROVIRAL THERAPY

It is assumed that combination ARV therapy was available from 1996. The observed uptake of monotherapy between 1993 and 1995 is assumed to have a relatively low effect of reducing disease progression compared to combination therapy, and that coverage was low. The model therefore assumes that before 1996, there was negligible effect of therapy on disease progression.

The effects of improved combination treatments on reducing the overall rate of progression to AIDS are estimated based on cases of AIDS reported and deaths following AIDS, and the changes in treatment effectiveness over the years are summarised in Table 9.

Table 9: Effects of ARV therapy on reducing disease progression rates.

Year	1996	1997	1998	1999	2000
Estimated reduction in progression rate	72%	47%	37%	31%	26%

The rates of diagnosis and treatment coverage, by disease stage, are given in Table 10.

Table 10: Rates of diagnosis and treatment coverage, by disease stage.

Disease stage	Undiagnosed	Diagnosed	Treated, among diagnosed
CD4 > 500/μl	20%	80%	40%
CD4 < 500/μl	10%	90%	70%
AIDS	0%	100%	90%

Effects of, and rates of ARV treatment, were assumed to be the same across all exposure groups.

2.4.4 MODELLED EPIDEMIOLOGICAL SCENARIOS

Section 2.5 presents the methods and results for the epidemiological modelling of the HIV epidemic within specific transmission routes for each of the identified populations. The total estimates of HIV incidence and prevalence of all the exposure categories under the different modelled scenarios are presented in Appendices B to E. The total number of people living with HIV/AIDS is broken down into those who are undiagnosed, diagnosed but untreated, and diagnosed and treated.

2.5 ESTIMATES AND PROJECTIONS OF THE HIV EPIDEMIC

2.5.1 HOMOSEXUAL CONTACT

From the Australian Study of Health and Relationships in 2001-2002, 2.9% of adult men in NSW identified as homosexual/gay (Rissel, Smith et al. 2003). It is assumed that there is a 1% annual increase in trends over the years. The homosexual male population in NSW is estimated to be about 40,000 men in 1980 increasing to about 69,000 in 2005, based on ABS data on the number of adult males in NSW.

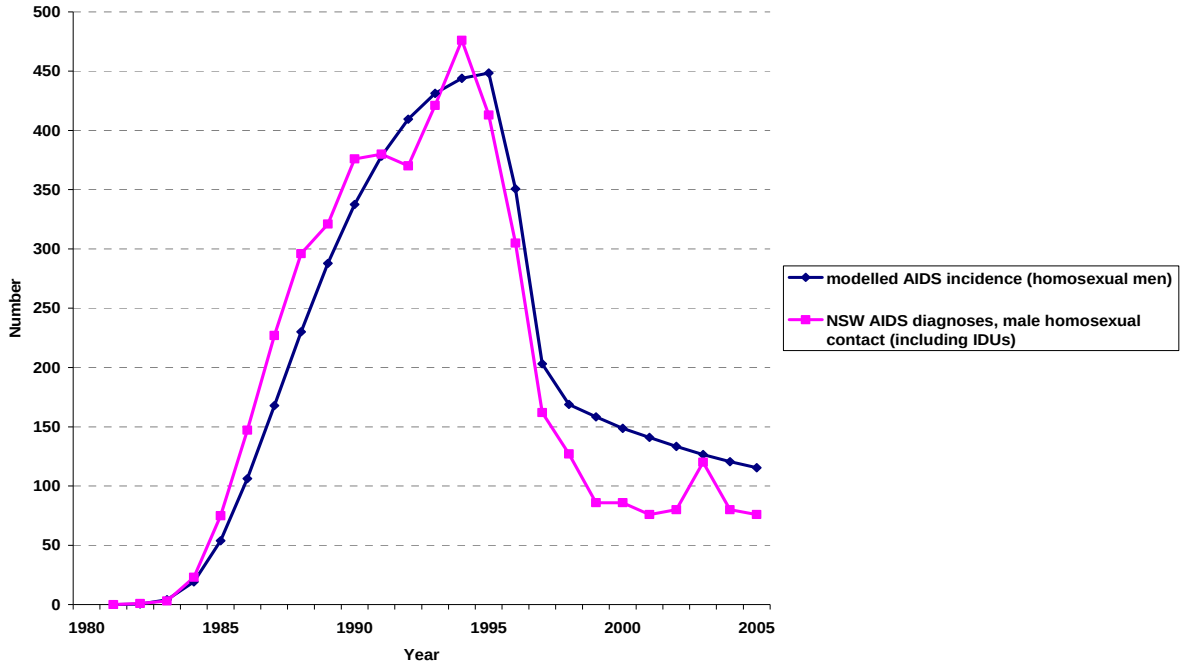
Estimates of HIV incidence among homosexual men between 1981-1999 are based on a previous back-projection model (NCHECR 2000). The back-projection estimates are based on Australian nation-wide HIV surveillance data and are scaled down to give NSW estimates using the annual proportions between 50% and 60%.

At the beginning of the epidemic, an assumption of high levels of unprotected anal intercourse (UAI) is required to fit the back-projection model. Between 1985 and 1989 a sharp reduction of UAI, between 20% and 40% annually is assumed, followed by a more gradual reduction in UAI levels from 5% in 1990 to 1% in 1994. It is assumed that the UAI risk level includes the prevalence of UAI among both regular and casual partnerships and also the effects of the prevalence of other sexually-transmitted infections in the homosexual population on HIV transmission. By 1996, coincident with the initiation of combination ARV therapy in Australia, UAI levels began to increase again by 10% per year between 1996 and 2001, but remained constant from 2002 onwards.

The average age of infection among homosexual men is assumed to be 31 years.

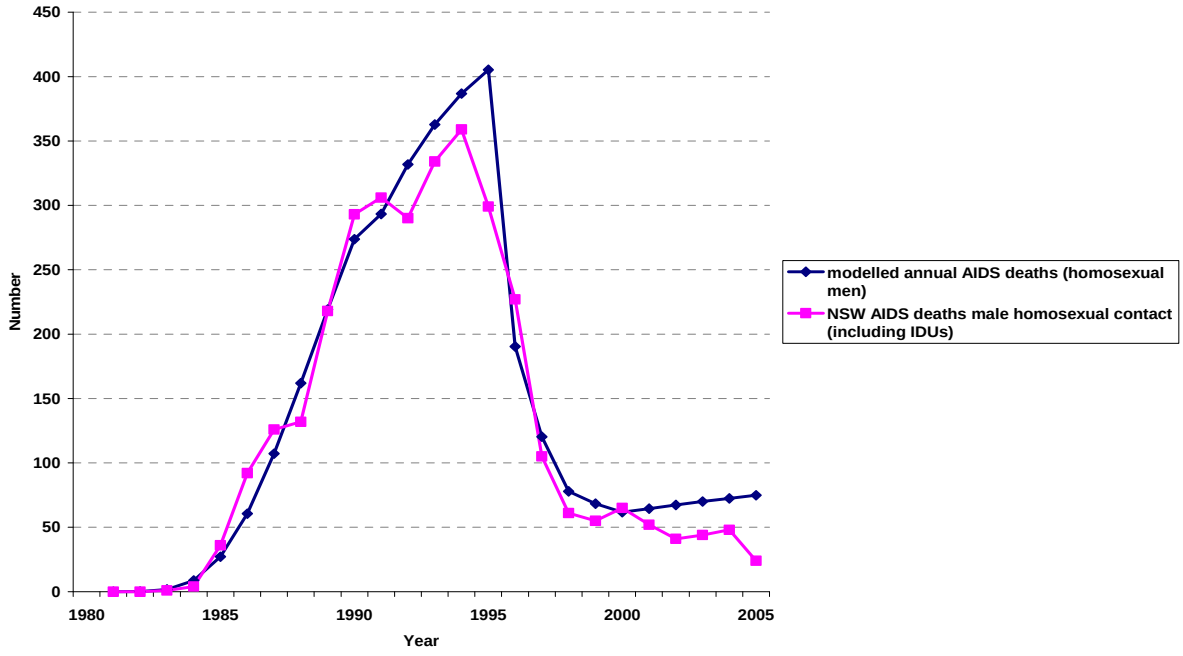
From the modelled estimates of HIV incidence (Table 8) and the disease progression model, the incidence of AIDS and deaths following AIDS among patients exposed to HIV through homosexual contact are estimated. Figures 5 and 6 show good agreement between observed data and the modelled estimates for AIDS incidence and annual AIDS deaths, respectively.

Figure 5: Modelled estimates of annual AIDS incidence and reported AIDS diagnoses (adjusted for reporting delay) among patients exposed through homosexual contact, NSW 1980–2005.



Source: National Centre in HIV Epidemiology and Clinical Research

Figure 6: Modelled estimates of annual number of deaths following AIDS and reported deaths following AIDS (adjusted for reporting delay) among patients exposed through homosexual contact, NSW 1980–2005.



Source: National Centre in HIV Epidemiology and Clinical Research

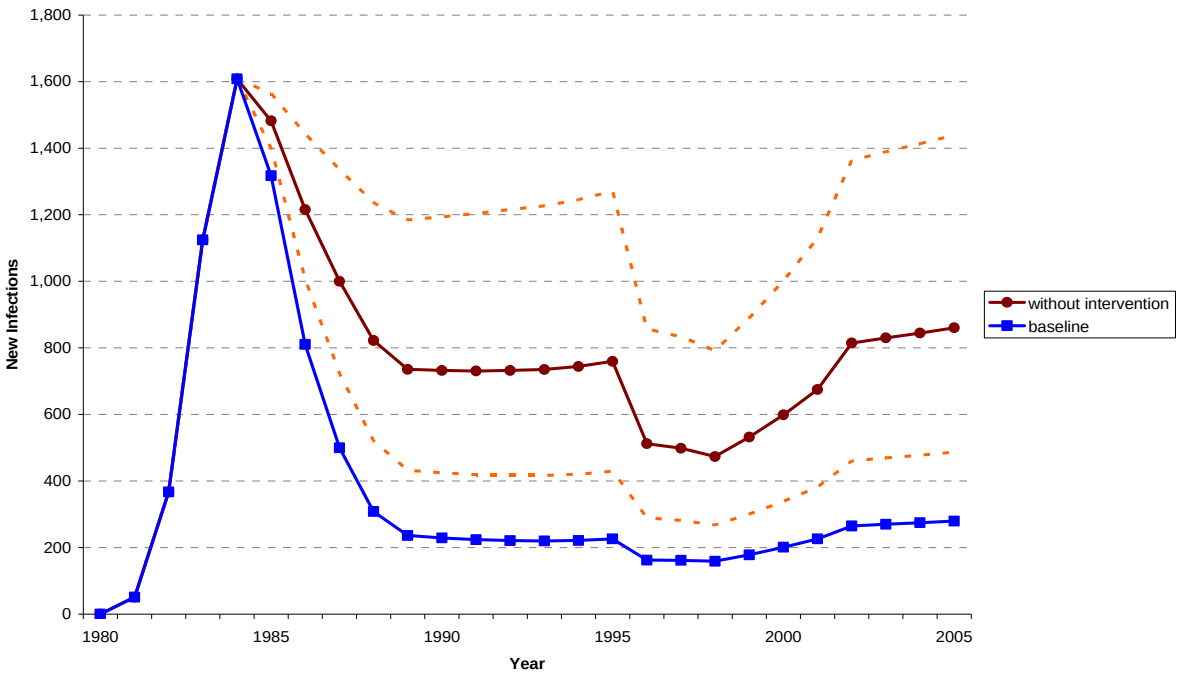
In the homosexual transmission model, an assumption was made in terms of what proportion of behaviour change is attributable to government-funded intervention through the NSW HIV/AIDS Program. Table 11 summarises the assumptions regarding interventions made in the model scenarios.

Table 11: Intervention level assumptions in the homosexual contact model scenarios.

Scenario	Behavioural intervention	Assumption
Current	Yes	Existing levels of intervention and impact on UAI risk behaviour
50% intervention	No	Absence of intervention corresponds to 50% of change in UAI levels
Lower limit	No	Absence of intervention corresponds to 25% of change in UAI levels
Upper limit	No	Absence of intervention corresponds to 75% of change in UAI levels

Figure 7 shows the estimated HIV incidence among homosexual men under the baseline scenario, and then under the different scenarios, reflecting what behaviour change might have occurred without the NSW HIV/AIDS Program.

Figure 7: HIV incidence among homosexual men, under baseline and no intervention scenarios, NSW 1981-2005.



* Dotted lines indicate lower and upper limits.

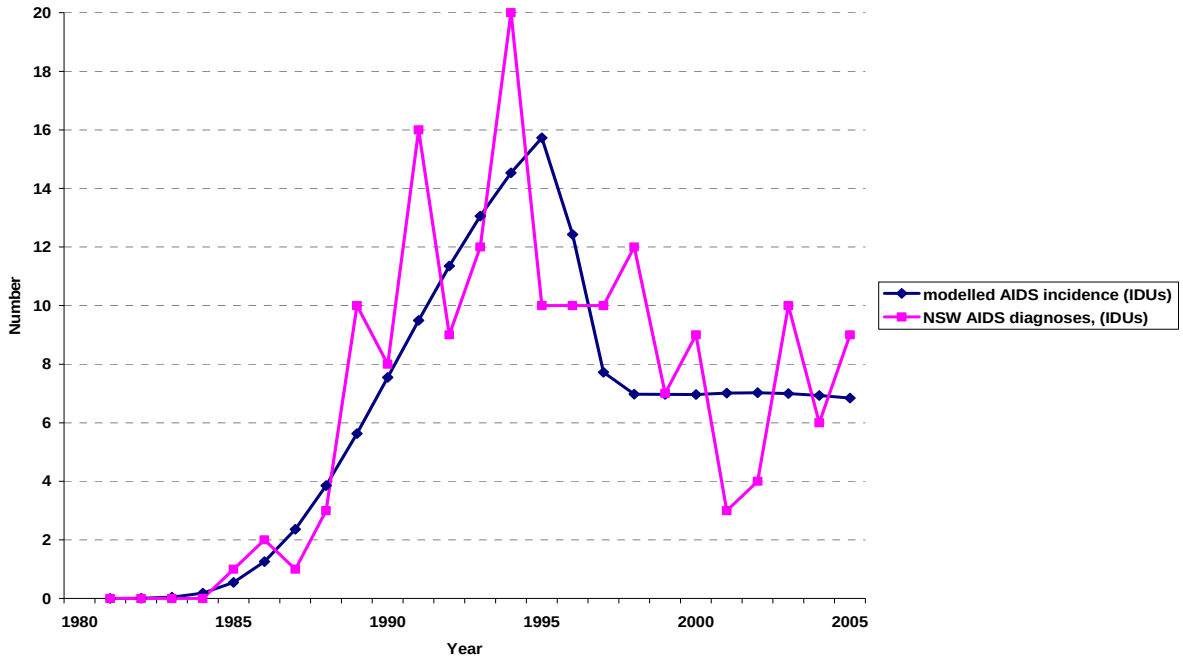
2.5.2 INJECTING DRUG USE

The size of the injecting drug user (IDU) population in NSW is estimated based on the report from the Hepatitis C Virus Projections Working Group (HCVPWG 2006). Data on needle and syringe distributions under the Needle and Syringe Program (NSP), drug-related arrests and opioid overdose deaths, hospitalisations and ambulance services indicate that 47% of IDUs are in NSW. The national estimates are scaled down accordingly to give NSW estimates.

The average age of infection among IDUs is assumed to be 30 years. It is assumed that there are three male HIV-infected IDUs to every female HIV-infected IDU.

From the modelled estimates of HIV incidence (Table 8) and the disease progression model, the incidence of AIDS and deaths following AIDS among patients exposed to HIV through injecting drug are estimated. Figures 8 and 9 show the comparison between observed data and the modelled estimates for AIDS incidence and annual AIDS deaths, respectively.

Figure 8: Modelled estimates of annual AIDS incidence and reported AIDS diagnoses (adjusted for reporting delay) among patients exposed through injecting drug use, NSW 1980-2005.



Source: National Centre in HIV Epidemiology and Clinical Research

Figure 9: Modelled estimates of annual number of deaths following AIDS and reported deaths following AIDS (adjusted for reporting delay) among patients exposed through injecting drug use, NSW 1980-2005.

Source: National Centre in HIV Epidemiology and Clinical Research

In the IDU HIV transmission model, the only intervention parameter modelled was the implementation of NSP. In the current baseline epidemic model, with the NSW HIV/AIDS Program, NSP implementation was modelled to have an impact on HIV incidence since its inception in 1988. The alternative (no NSW HIV/AIDS Program) scenario removes the impact of NSP on HIV incidence, under the assumption that the effect of NSPs in reducing HIV transmission among IDUs corresponds to an annual reduction in (logit) HIV prevalence of 0.28. This estimate of the effect of NSPs is based on a comparison of HIV prevalence in cities that ever had NSPs with cities that never had NSPs (HOI, NCHECR et al. 2002).

Figures 10 and 11 show the HIV incidence under the current baseline scenario (with NSP) and the alternative scenario (without NSP), respectively.

Figure 10: HIV incidence among injecting drug users, under current baseline scenario (with NSP), NSW 1981-2005.

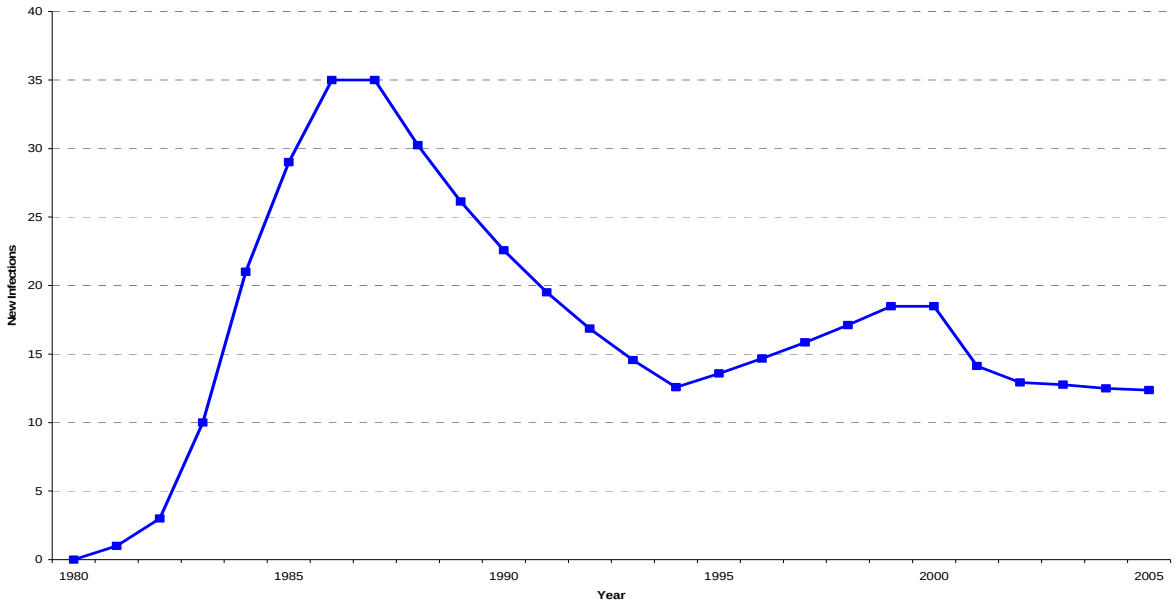
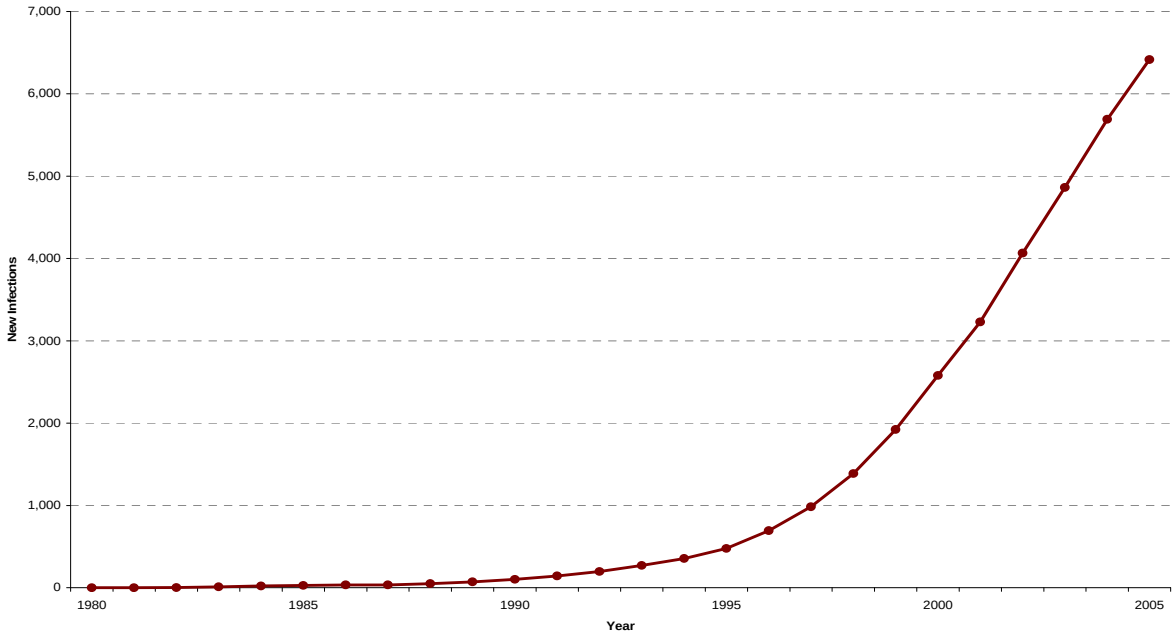


Figure 11: HIV incidence among injecting drug users, under alternative scenario (without NSP), NSW 1981-2005.



2.5.3 HETEROSEXUAL CONTACT

The back-projection model provides estimates for HIV incidence among females through heterosexual contact (NCHECR 2000). Surveillance data on diagnosed AIDS cases in NSW indicate that 64% of cases acquired through heterosexual contact were male. The incidence estimates are thus adjusted accordingly to include both males and females.

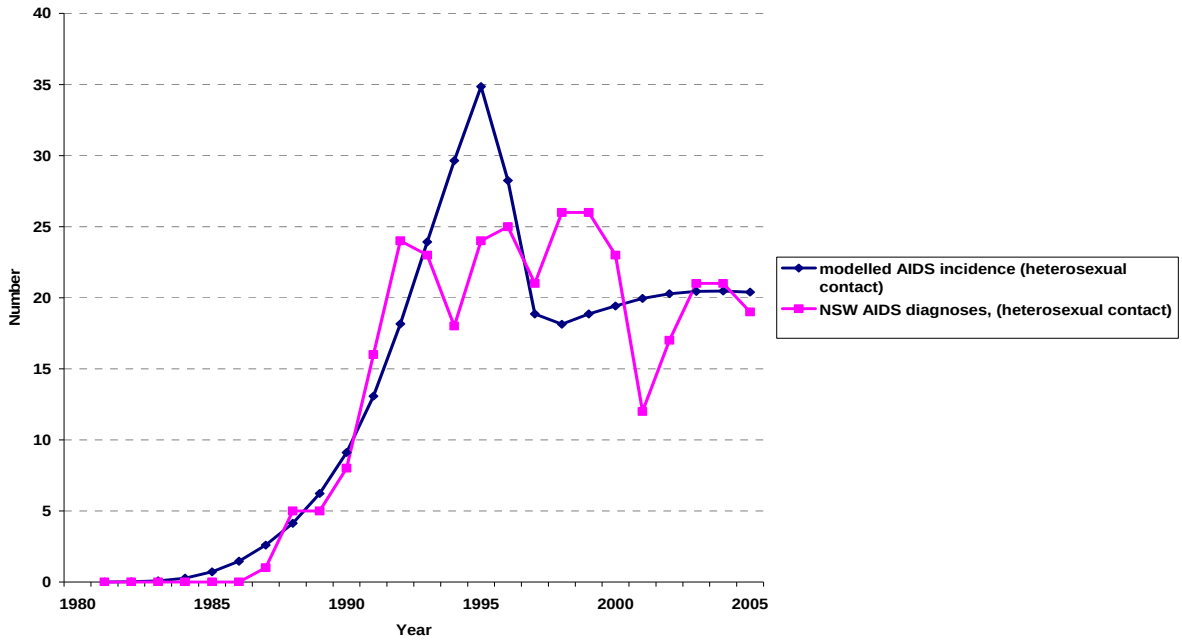
Based on data on the exposure history of newly-diagnosed HIV infections, recorded exposure categories upon notifications, and exposure history of women with perinatally HIV-exposed children from the Annual Surveillance Reports, it is assumed that of the number of cases acquired

through heterosexual contact, about one-third are among migrants from countries of high HIV prevalence (NCHECR 2006). In the estimation model, the assumed percentages of cases attributed to heterosexual contact overseas are taken as 35% between 1980 and 1984, 32% between 1985 and 1995, 35% between 1996 and 1999, and 40% between 2000 and 2001.

To fit the back-projection model and the surveillance data, the incidence model assumed that the risk behaviour (unprotected sex) among heterosexual contacts changed over the period of the epidemic. For the models to fit incidence data, risk behaviour was decreased by 20% per year from the peak in 1985. In the early 1990s, risk levels further decreased by 2% annually, but increased again by 10% per year between 1996 and 2002 and plateaued from 2002 onwards.

From the modelled estimates of HIV incidence (Table 8) and the disease progression model, the incidence of AIDS and deaths following AIDS among patients exposed to HIV through heterosexual contact are estimated. Figures 12 and 13 show the comparison between observed data from the HIV surveillance database and the modelled estimates for AIDS incidence and annual AIDS deaths, respectively.

Figure 12: Modelled estimates of annual AIDS incidence and reported AIDS diagnoses (adjusted for reporting delay) among patients exposed through heterosexual contact, NSW 1980–2005.



Source: National Centre in HIV Epidemiology and Clinical Research

Figure 13: Modelled estimates of annual number of deaths following AIDS and reported deaths following AIDS (adjusted for reporting delay) among patients exposed through heterosexual contact, NSW 1980–2005.

Source: National Centre in HIV Epidemiology and Clinical Research

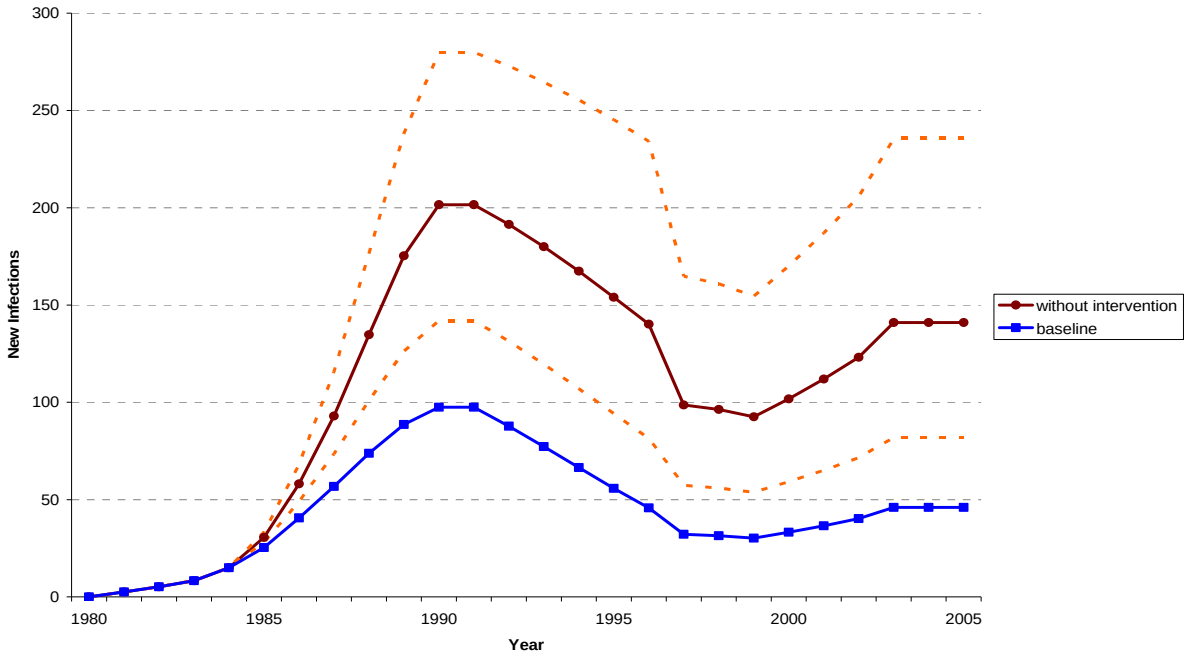
Table 12 summarises the assumptions made in the heterosexual contact model regarding behaviour change with and without the government funded interventions through the NSW HIV/AIDS Program.

Table 12: Intervention level assumptions in the heterosexual contact model scenarios.

Scenario	Intervention	Assumption
Current	Yes	Existing levels of intervention and impact on risk behaviour
50% intervention	No	Absence of intervention corresponds to 50% of change in risk levels
Lower limit	No	Absence of intervention corresponds to 25% of change in risk levels
Upper limit	No	Absence of intervention corresponds to 75% of change in risk levels

Figure 14 shows the estimated HIV incidence through heterosexual contact (total males and females), under the different scenarios.

Figure 14: HIV incidence through heterosexual contact, under different intervention scenarios, NSW 1981-2005.



* Dotted lines indicate lower and upper limits.

2.5.4 HETEROSEXUAL CONTACT THROUGH COMMERCIAL SEX

It is estimated that there are a total of 7,000 brothel-based commercial sex workers (CSWs) and 200 street-based CSWs in NSW (Donovan B, pers. comm.). HIV prevalence is assumed to be 0.1% among the brothel-based CSWs and 1% among street-based CSWs since 1985. A linear increase in prevalence is assumed prior to 1985. For both groups of female CSWs, the average number of clients per week is taken as 20 (Escourt, Marks et al. 2000), with the per act transmission probability taken as 0.001 (Gray, Wawer et al. 2001). Condom use in commercial sex acts is assumed to be 98% among brothel-based CSWs and 90% among street-based CSWs since 1985, with a linear increase to that level between 1980 and 1985. Condom use is assumed to give a 95% protection against the per-act transmission of HIV.

In this analysis, the impact of HIV through commercial heterosexual contact is reflected in the annual numbers of men (clients of CSWs) acquiring HIV infections through commercial sex acts with CSWs. Limited data has prevented more detailed modelling of HIV among CSWs, and in particular we did not attempt to model increased transmission from clients to CSWs, or from clients to other partners. However, our estimates of numbers of clients infected through contact with CSWs can be regarded as conservative (lower) estimates of the effect of the NSW HIV/AIDS Program on HIV incidence as a result of commercial sex work.

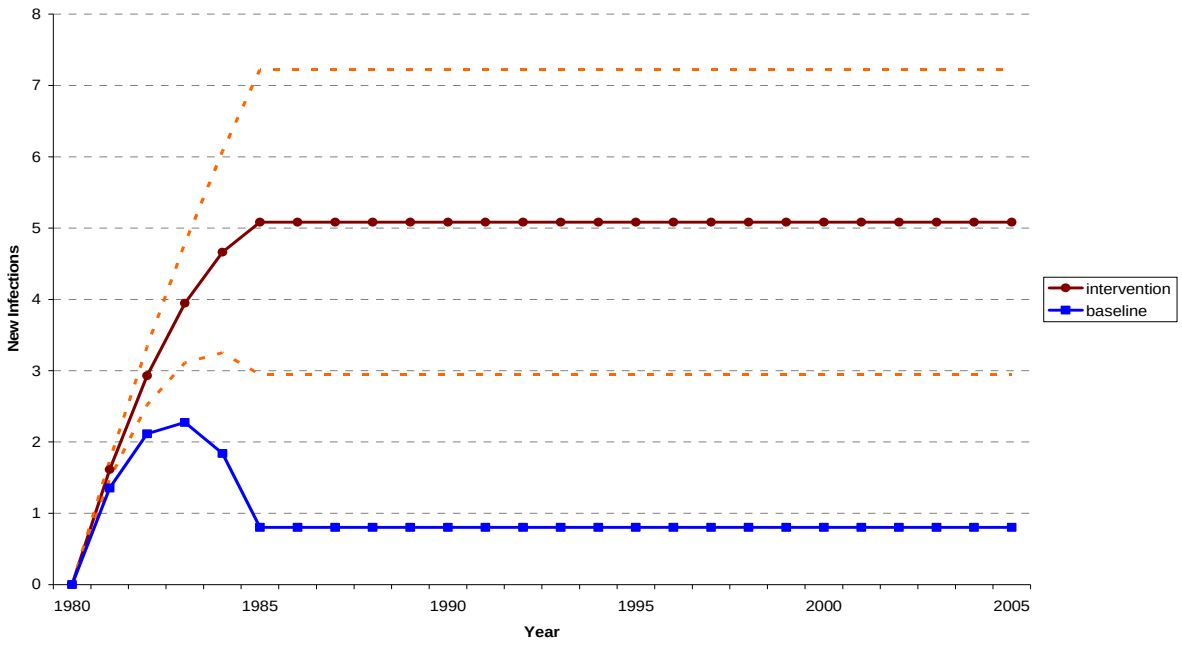
Table 13 summarises the assumptions in the heterosexual contact through commercial sex model scenarios regarding behaviour change with and without government-funded interventions through the NSW HIV/AIDS Program.

Table 13: Intervention level assumptions in the exposure through commercial sex model scenarios.

Scenario	Intervention	Assumption
Current	Yes	Existing levels of intervention and impact on risk behaviour
50% intervention	No	Absence of intervention corresponds to 50% of change in risk levels
Lower limit	No	Absence of intervention corresponds to 25% of change in risk levels
Upper limit	No	Absence of intervention corresponds to 75% of change in risk levels

Figure 15 shows the estimate HIV incidence through heterosexual commercial sex contact (clients of CSWs), under the different scenarios.

Figure 15: HIV incidence through heterosexual contact in commercial sex (clients of female sex workers), under different intervention scenarios, NSW 1981-2005.



*

Dotted lines indicate lower and upper limits.

In interpreting these estimates of HIV incidence in male clients of female CSWs, it is important to recognise certain limitations. There have been no reported HIV diagnoses in NSW attributed to female sex work, either as transmissions to or from female sex workers. It is also known that HIV prevalence among brothel-based sex workers in NSW is extremely low. This lack of data and known very low baseline precluded the development of a formal transmission model of HIV transmission through female sex work.

Hence, in this analysis, the impact of HIV through commercial heterosexual contact is only reflected in the annual numbers of men (clients of CSWs) acquiring HIV infections through commercial sex acts with CSWs. Limited data has prevented more detailed modelling of HIV among CSWs. In particular we did not attempt to model increased transmission from clients to CSWs, or from clients to other partners. Furthermore, we have not attempted to model the extent to which increased HIV transmission from CSWs to their clients would propagate into a larger and more generalised heterosexual HIV epidemic. Thus, our estimate of numbers of clients infected

through contact with CSWs may be regarded as very conservative (i.e. lower) estimates of the effect of the NSW HIV/AIDS program on HIV incidence as a result of commercial sex work, as it only estimates the direct effect on HIV transmission from CSWs to their clients, and does not include the secondary HIV transmission that would have occurred from those HIV-infected clients either back to other CSWs or to other heterosexual partners, and hence onto a more generalised heterosexual HIV epidemic.

To gauge quantitatively the possible extent of this underestimation, consider, for example, if each heterosexual HIV-infected client were to lead, on average, to one further heterosexually transmitted HIV infection, If this were the case, then the increased rate of HIV infections among clients in Figure 15 would need to be doubled to allow for secondary transmission. Unfortunately, data on what the true average rate of secondary transmission from HIV-infected clients is not available in Australia, so to judge this accurately is not possible. For this reason, we did not attempt to model secondary transmission from clients onwards, but the conservative nature of our estimates should be considered when interpreting the results.

International experience suggests that female sex workers are an important bridging population for HIV transmission. The success in NSW of essentially avoiding an HIV epidemic among IDUs has also had the effect of keeping HIV prevalence very low among female sex workers who inject drugs. However, it is also possible that if HIV prevalence increased among heterosexual populations in NSW, female sex work could seed and promote a larger HIV epidemic among IDUs and the wider heterosexual community. This suggests that it may be wise to retain investment in promoting safe sex among female sex workers as insurance against the possibility of increased HIV epidemics among IDU and heterosexual populations, and to avoid an HIV epidemic bridging from one population to the other.

2.5.5 PROJECTIONS OF THE EPIDEMIC, 2006–2016

A separate set of incidence projections is modelled for the HIV epidemic between 2006 and 2016, to assess what might be the impact of terminating the existing NSW HIV/AIDS Program. The four HIV exposure group models are projected until 2016 under two scenarios. First, the baseline scenario, where it is assumed that the NSW HIV/AIDS Program remains in place, and levels of risk behaviours remain at 2005 levels between 2006 and 2016. The second scenario assumes that the NSW HIV/AIDS Program is terminated. The models assume that if the NSW government-funded intervention measures cease, then there will be a gradual decrease in their impact on risk behaviours. It is assumed that this corresponds to a linear increase over a five-year period between 2007 and 2012, to a level equal to 50% of risk behaviour levels at the peak of the HIV epidemic in 1985, and that risk behaviour levels plateau thereafter until 2016. HIV incidence and prevalence are estimated for the period 2006 to 2016, and the total number of people living with HIV/AIDS in 2016 is modelled forward until 2100, by which time all are estimated to have died.

Figures 16 to 19 show the projected incidence between 2006 and 2016 under the two scenarios, for male homosexual contact, injecting drug use, heterosexual contact and heterosexual contact though commercial sex (clients of female sex workers), respectively.

In all risk groups, the models suggest that HIV incidence would remain broadly stable at 2006 levels if the NSW HIV AIDS Program remained in place, and other factors remain constant at 2005 levels. If NSPs were ceased among injecting drug users, the models suggest a rapid increase in HIV incidence (Figure 17). In other risk groups the models assume that ceasing NSW Health intervention strategies would result in a gradual increase in risk behaviours, to 50% of the risk behaviour levels seen at the peak of the epidemic by 2012, followed by a plateau in risk behaviour. In these risk groups, this results in a similar pattern of HIV incidence under the ceasing intervention scenario, with a quite rapid increase in HIV incidence between 2007 and 2012, the period over which risk behaviour is assumed to increase, followed by something of a plateau, albeit at an increased HIV incidence rate, from 2012 onwards

Figure 16: Projected HIV incidence through male homosexual contact, under different intervention scenarios, NSW 2006-2016.

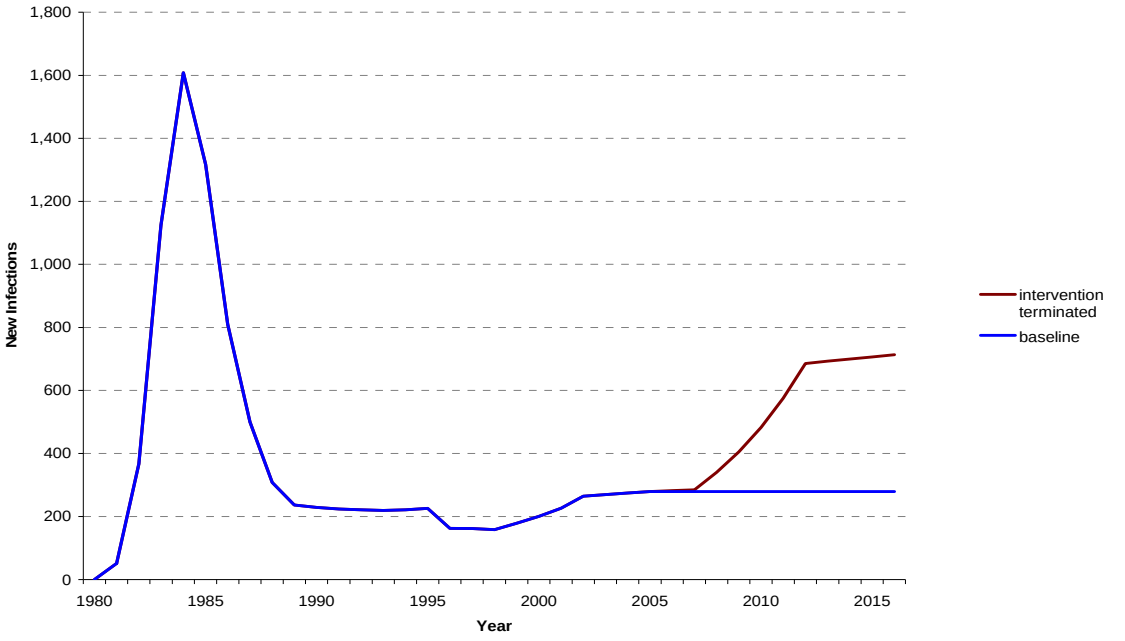


Figure 17: Projected HIV incidence through injecting drug use, under different intervention scenarios, NSW 2006-2016.

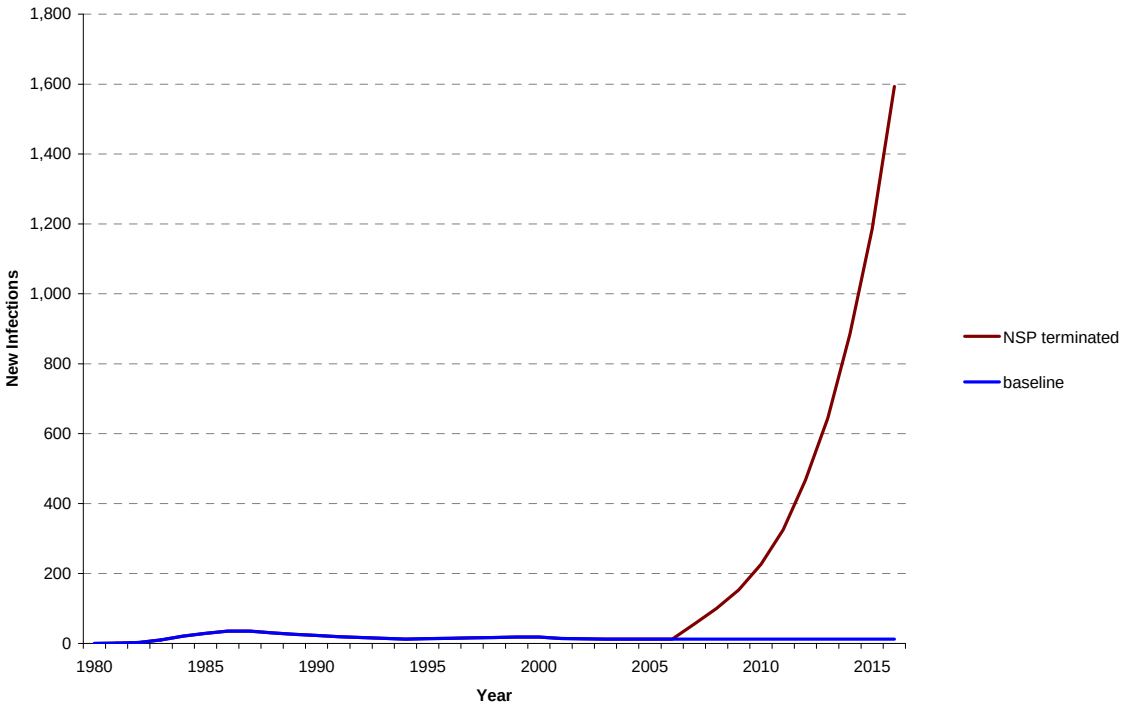


Figure 18: Projected HIV incidence through heterosexual contact, under different intervention scenarios, NSW 2006-2016.

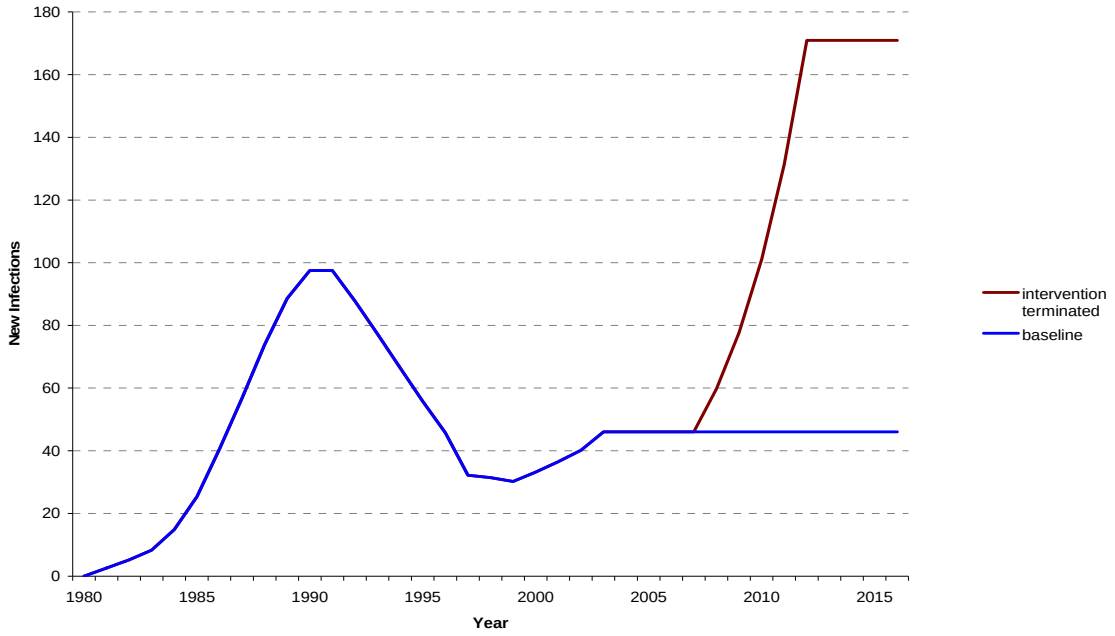
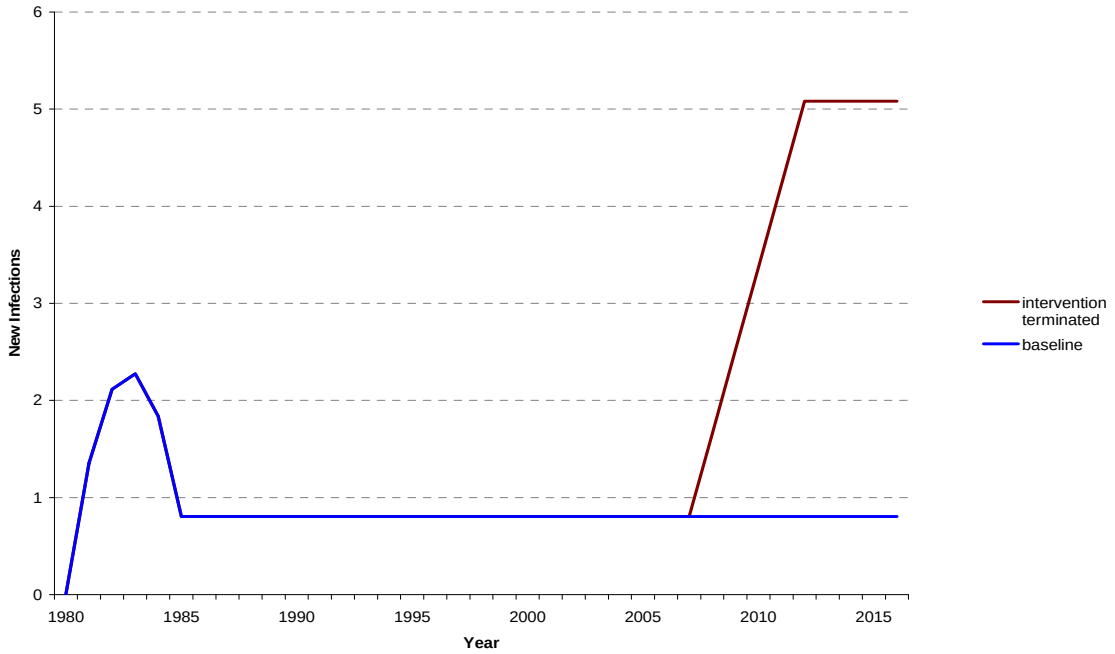


Figure 19: Projected HIV incidence through heterosexual contact in commercial sex (clients of female sex workers), under different intervention scenarios, NSW 2006-2016.



2.5.6 ESTIMATES AND PROJECTIONS OF PEOPLE LIVING WITH HIV/AIDS IN NSW

The estimated numbers of people living with HIV/AIDS by exposure category are summed to give the total estimate for NSW. A summary of the projected numbers is given in Table 14.

Table 14: Projected number of people living with HIV/AIDS, by exposure category, under different scenarios, NSW 2005 and 2016.

Year	People living with HIV/AIDS				Total
	Male homosexual contact	Injecting drug use	Heterosexual contact	Clients of female sex workers	
Baseline model					
2005	6,230	340	1,000	17	7,587
2016	8,360	430	1,370	24	10,184
No intervention since 1980					
2005	14,670	33,040	2,460	97	50,267
Stop intervention from 2006					
2016	11,140	5,890	2,180	53	19,263

Note: "Total" is sum of the four exposure groups only, and excludes other sub-populations and those for whom exposure is unknown/undetermined.

The differences in the total people living with HIV/AIDS under the two scenarios (projected baseline epidemic compared to absence of the NSW HIV/AIDS Program) for the 1980–2005 estimates and the 2006–2016 projected epidemic are shown in Figures 20 and 21, respectively.

Figure 20: Estimated number of people living with HIV/AIDS, under different intervention scenarios, based on modelled HIV incidence for NSW, 1980-2005.

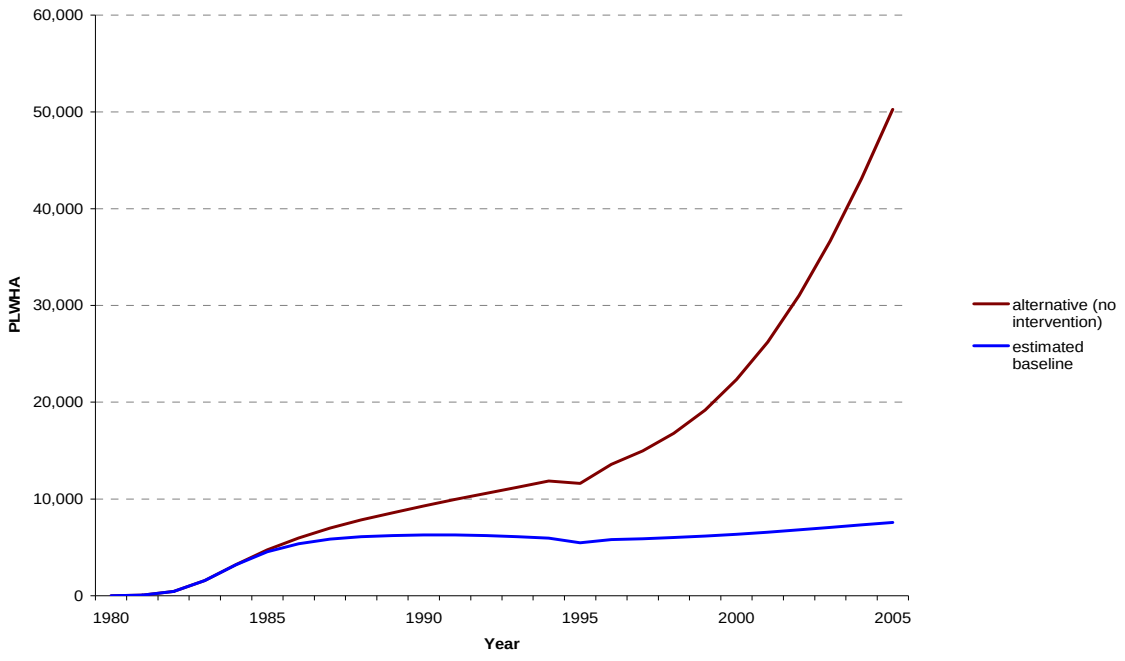
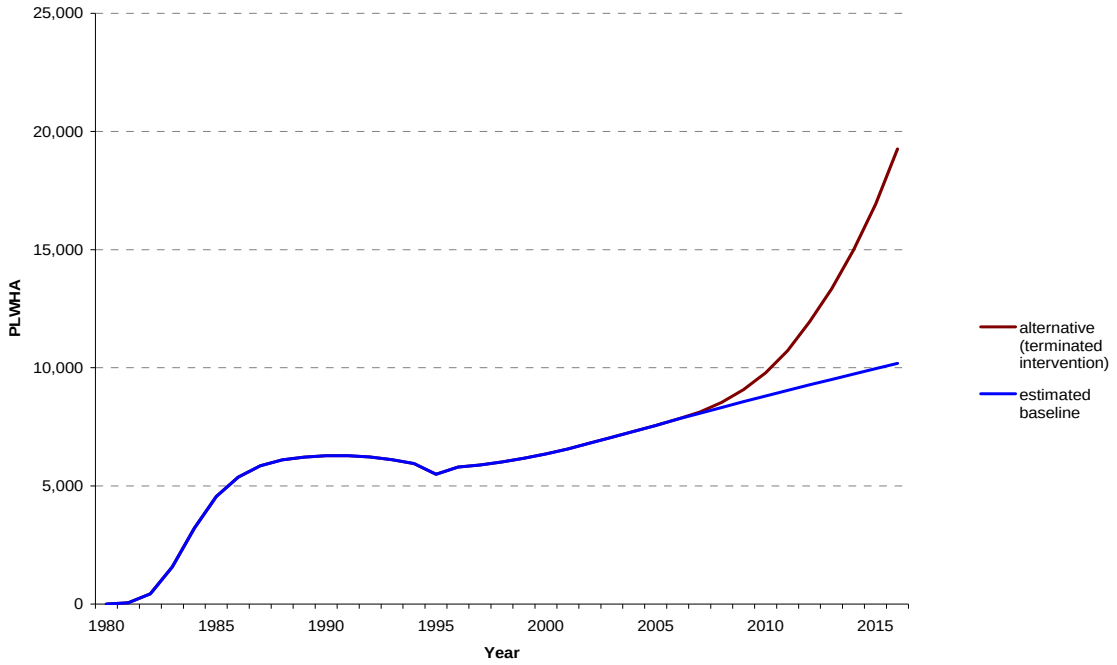


Figure 21: Projected number of people living with HIV/AIDS, under different intervention scenarios, based on modelled HIV incidence for NSW, 2006-2016.



The estimated 7,587 people living with HIV in 2005 under the baseline model is somewhat lower than the total number of people diagnosed with HIV in NSW (13,554 in Table 1) minus deaths follow AIDS (3,710 in Table 4). This discrepancy in part may reflect duplicate reporting of HIV diagnoses, under-reporting of AIDS and under-reporting of deaths following AIDS. The estimated total of 7,587 people living with HIV is also the sum of the four exposure categories considered in this analysis, and in particular does not account for HIV diagnoses that were reported with other and undetermined source of HIV infection. The estimated 7,587 people living with HIV in 2005 is more consistent with the national estimate of 15,300 people living with HIV in 2005, with NSW forming 56% of all HIV diagnoses in Australia (NCHECR, 2006).

The apparent discrepancy may also partly attributable to our modelling methodology. We chose to calibrate our baseline estimates of HIV incidence to previous national back-projection estimates. The advantage of this approach is that it anchors the HIV transmission models to previously published, objective estimates of HIV incidence over the period 1980 to 1995. However, it may be that these back-projection estimates have underestimated HIV incidence, particularly during the mid-1990s. The availability of HAART at this time had a large but unquantifiable effect on delaying progression to AIDS, and so rendered back-projections analyses obsolete. In particular, back-projection estimates of HIV incidence in the mid-1990s, which are then essentially carried forward by the transmission models, are based on limited data and are particularly uncertain.

It is also worth noting that in the models, the effect of the NSW HIV/AIDS Program acts multiplicatively on rates of HIV transmission. This means that, if the baseline estimates of HIV incidence are underestimates, the absolute numbers of HIV infections avoided through the NSW HIV/AIDS program would be underestimated by this approach. The cost-effectiveness of the NSW HIV/AIDS Program may therefore be underestimated. Overall, our approach, which is based on previous objective estimates of HIV incidence that leads to conservative estimates of cost-effectiveness, seems appropriate, even if baseline estimates of people living with HIV in NSW appear somewhat low.

3

ECONOMIC ANALYSIS

3.1 INTRODUCTION

The second stage of the study, undertaken by Health Outcomes International Pty Ltd (HOI) was an analysis of the economic and related impacts of the Program. These include:

- Identification and analysis of the funds expended under the NSW HIV/AIDS Program from its inception to 2005;
- Identification of the direct costs of clinical care met by NSW Health for HIV/AIDS for affected persons;
- Identification of the impacts of HIV/AIDS on quality of life for affected persons, in terms of Quality Adjusted Life Years (QALYs); and
- Application of these data to the projections prepared by NCHECR in the previous component of the study in an economic model to illustrate the economic impact of the Program in terms of clinical care costs avoided and life years and QALYs saved.

3.2 DESCRIPTION OF THE ECONOMIC MODEL

The model used to analyse the financial impact of the NSW HIV/AIDS Program examines the funds invested under the Program, and compares these funds to the future financial savings and other benefits that are estimated to flow from that investment. Both the investment and cost savings used in the analysis are restricted to those that have or would be incurred by NSW Health, and exclude those that are met by other sources, such as those met by the Commonwealth. These include the costs of antiretroviral treatment (HAART) estimated at approximately $10,000 per patient per annum.

In the epidemiological analysis presented in the previous chapter, the impact of clinical care is assumed under both the baseline analysis and the various prevention strategies undertaken for the different target populations. It is recognised that clinical care brings with it considerable benefits in regard to slowing the rate of disease progression, and improved morbidity and mortality for participants. It may also reduce HIV incidence by reducing viral load, infectiousness and hence disease transmission. However, the complexity of the inter-relationship between the preventative effects of clinical care and other preventative initiatives funded under the Program precluded the inclusion of the benefits of clinical care in the model. In addition, it was assumed that, in the context of existing prevalence of HIV/AIDS in NSW, some ongoing investment in clinical care would be provided, and that it would not be feasible to develop reasonable scenarios regarding a scaling back of the investment in clinical care. Consequently, in the economic analysis in this study, the return on investment is based on the funds invested by the NSW Government in prevention activities, and determined for each of the identified target populations and for the program as a whole. This approach also enabled a comparison to be made to other public health/prevention programs.

Future financial savings relate to the direct lifetime costs of clinical care met by NSW Health for cases of HIV/AIDS that would have occurred but for the prevention activities funded under the Program. In this context, clinical care costs refer to the direct costs of providing medical and allied health care of HIV/AIDS via public sector facilities and via funded non-government

organisations that are met by the NSW Government. Because the Program investment has occurred over 25 years to date, while the savings will continue to accrue into the future over the lifetime of the HIV cases avoided, the cashflows associated with both the investment and the future benefits are discounted to a common reference point, namely the commencement of the investment period (1981/82). The difference between these two cashflow streams after discounting, known as the Net Present Value (NPV), takes into account the fact that a dollar today is valued more highly than a dollar in, say, ten years, and thus converts them to a common dollar equivalent. The concept of discounting cashflows thus enables us to assess the current value of future costs and savings for any investment decision.

3.3 NSW HIV PROGRAM EXPENDITURE

The AIDS/Infectious Diseases Branch of NSW Health provided data on funds allocated under the NSW HIV/AIDS Program to the NSW Department of Health, Area Health Services and non-government organisations involved in the delivery of services under the Program from 1981/82 to 2005/06. It should be noted that these data represent funds allocated, and may exclude local investment which has been made by some AHS at different points in time. These data were analysed to identify trends and themes, with some adjustments made to cater for data limitations and apparent reporting anomalies over time. However, neither the adjustments made nor the basis of reporting are considered to have had a material impact on the reliability of the estimates.

Total Program funding was then apportioned between that allocated for clinical care and that with prevention as its primary function. For example, clinical services funding was allocated 90% to clinical care and 10% to prevention; health promotion and NSP funds were allocated 100% to prevention, and all other funding allocations were apportioned (following advice from NSW Health) on the basis of 70% to clinical care and 30% to prevention activities (based on the Evaluation of the HIV/AIDS Health Promotion Plan).

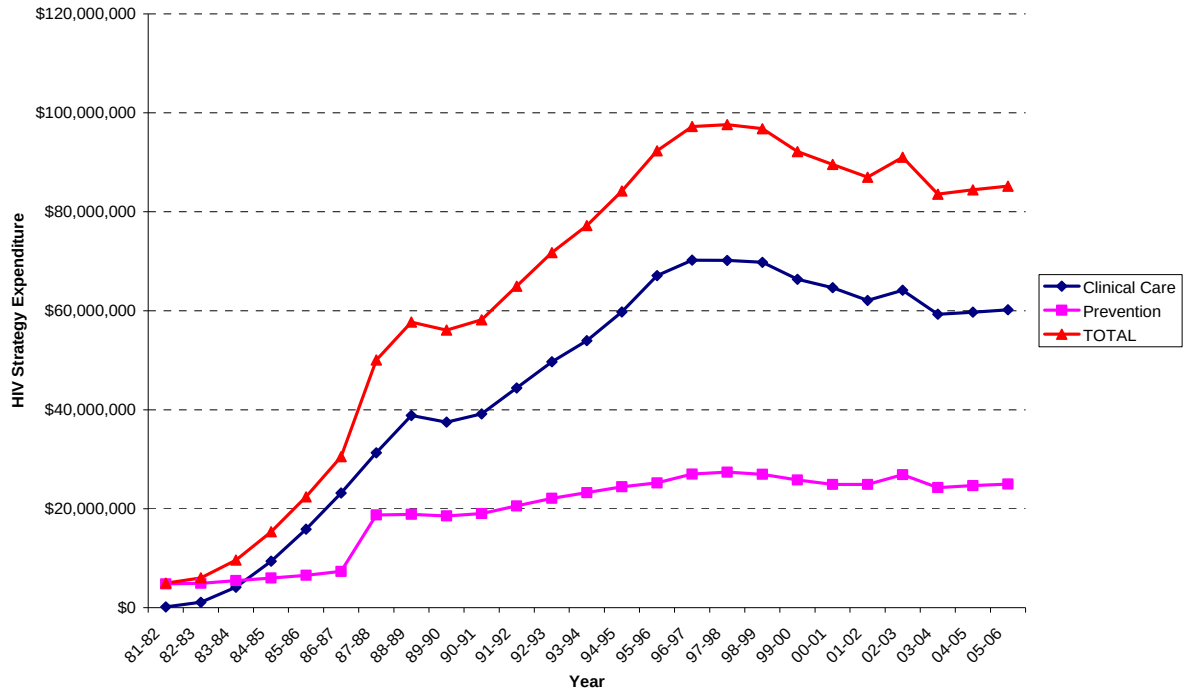
Table 15 summarises the expenditure over the 25 year period in original dollar values and in 2005/06 prices.

Table 15: Funds allocated under the NSW HIV/AIDS Program, 1981/82 to 2005/06.

Allocation	Original Value	2005/06 Dollars	%
Clinical Care	$885,338,616	$1,122,299,444	69.9%
Prevention	$373,376,125	$483,698,791	30.1%
Total	**$1,258,714,741**	**$1,605,998,235**	**100.0%**

In total, an estimated $1,259 million was allocated under the Program from 1981/82 to 2005/06 ($1,606 million in 2005/06 prices) with 70% allocated to clinical care and 30% to prevention activities. Trends in allocations over the funding period are illustrated in Figure 22.

Figure 22: Funds allocated to HIV/AIDS clinical care and prevention activities, NSW 1980/81-2005/06 (2005/06 prices).



Both clinical care and prevention allocations increased throughout the period. Clinical care allocations largely followed the number of persons with HIV/AIDS during the period, with the dampening effect of highly active antiretroviral treatments (HAART) on other clinical care costs evident from the mid-1990s. (Note that the costs of HAART are excluded from the above costs, as these are met by the Commonwealth). Prevention funds showed a steady increase over the period, with a significant increase from 1987/88 following the introduction of NSPs.

Prevention funds were than apportioned to the various target populations, based on advice from NSW Health as follows:

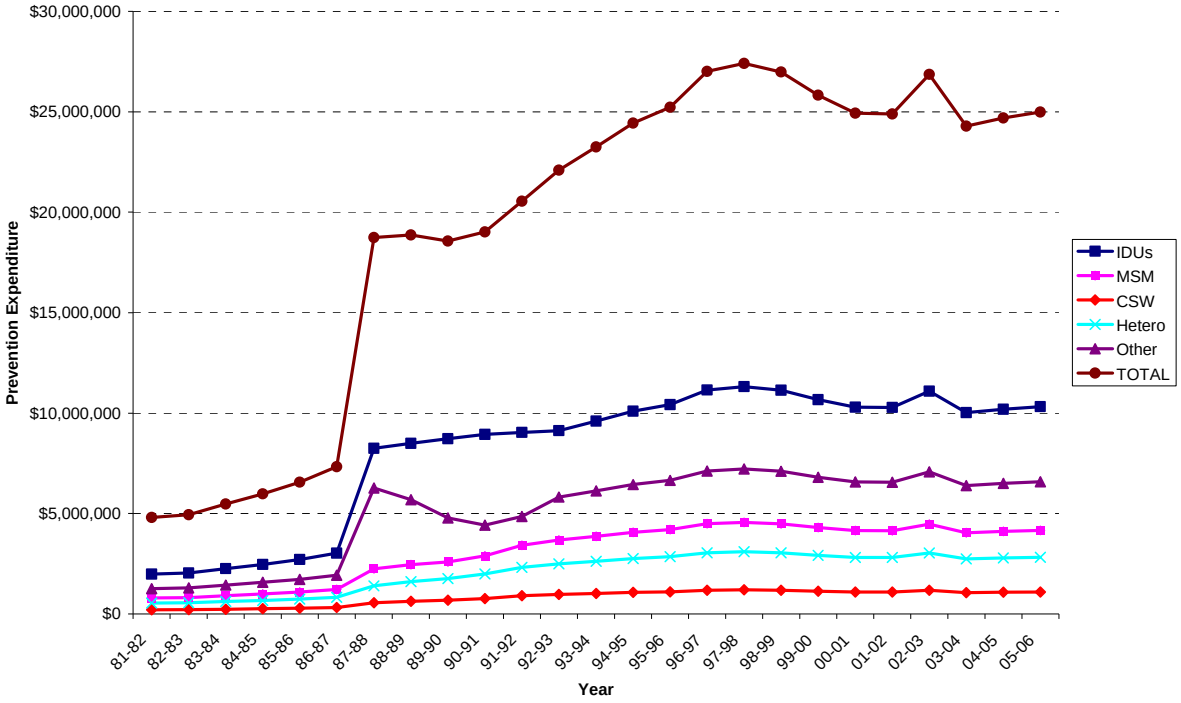
- Injecting drug users (IDUs): 42.11%
- Men who have sex with men (MSM): 16.17%
- Heterosexual and general population (Hetero): 10.94%
- Commercial sex workers (CSW): 4.26%
- Other: 26.52%

Funds allocated (in 2005/06 prices) to the various target populations under this formula are presented in Table 16, with the time series illustrated in Figure 23.

Table 16: Prevention funds allocated to target populations, 1981/82 to 2005/06 (2005/06 prices).

Target Population	Allocation ($ million)	%
IDUs	$203.7	42.1%
MSM	$78.2	16.2%
Hetero	$52.9	10.9%
CSW	$20.6	4.3%
Other	$128.3	26.5%
Total	**$483.7**	**100.0%**

Figure 23: Prevention funds allocated to target populations, NSW 1980/81-2005/06 (2005/06 prices).



Funding of prevention activities across all population groups increased at a relatively steady rate throughout the period, with a significant increase in the funding allocated to needle and syringe programs in the late 1980s and maintained thereafter.

3.4 HIV CASES AVOIDED UNDER THE PROGRAM

3.4.1 IMPACT TO DATE

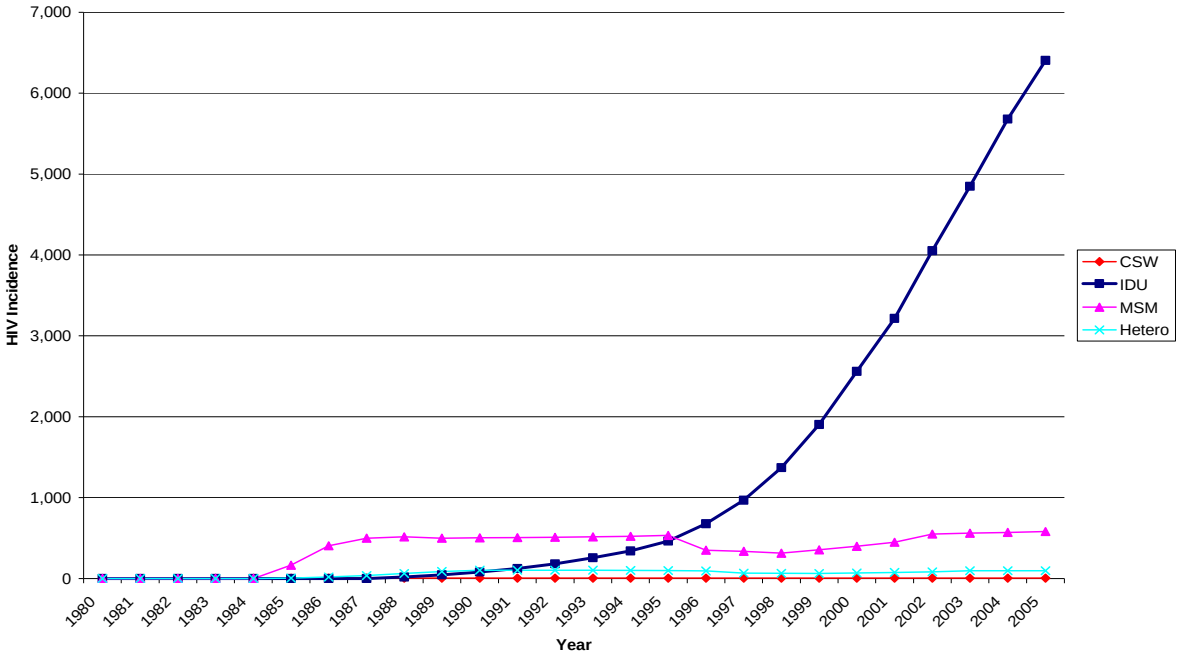
Based on the analysis undertaken by NCHECR and presented in the previous chapter, the total number of cases of HIV avoided between 1980 and 2005 as a result of the various preventative initiatives funded under the Program has been estimated at 44,545 cases, as demonstrated in Table 17. Overall, this represents an estimated 80% reduction in the number of new cases of HIV that would otherwise have occurred during this period in the absence of the preventative initiatives implemented in NSW. The estimated reduction in HIV incidence ranged from 99% among injecting drug users to 50% among homosexual men.

Table 17: Total HIV cases avoided by HIV/AIDS Program, NSW 1980-2005.

Group	Baseline	No Intervention	Cases Avoided	% Reduction
MSM	9,843	19,479	9,636	49.5%
IDU	439	33,633	33,193	98.7%
HTR	1,186	2,806	1,620	57.7%
CSW	24	120	95	79.2%
Total	**11,492**	**56,038**	**44,545**	**79.5%**

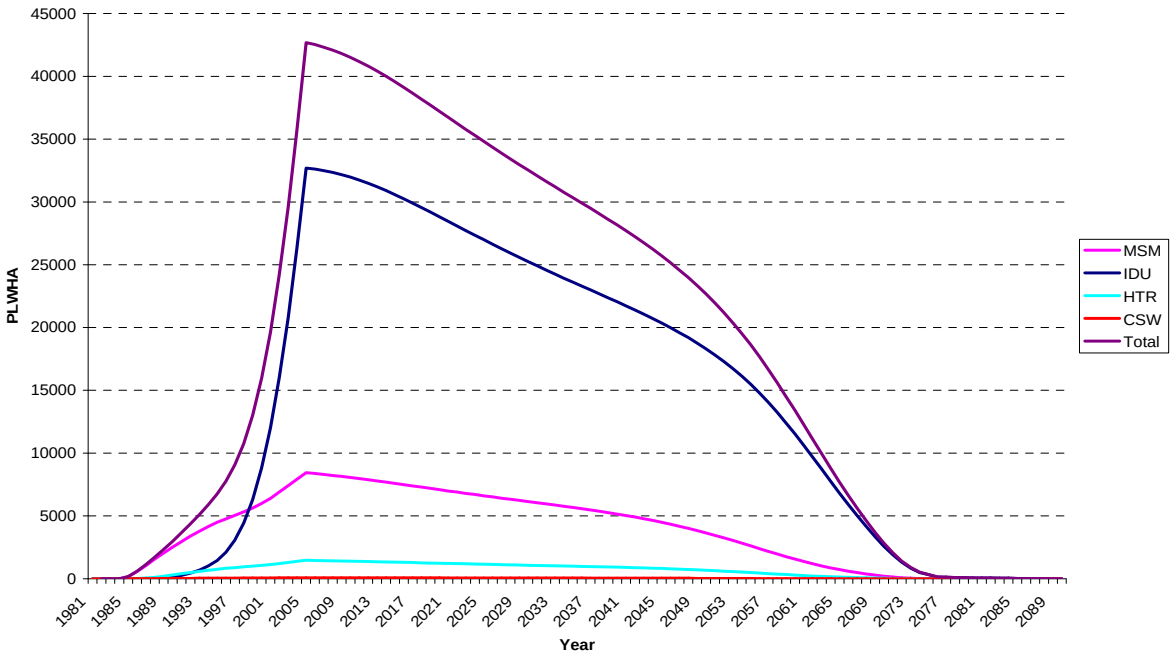
The impact of the preventative strategies on incidence rates for HIV during the 25 year period to 2005 is illustrated in Figure 24. The increasing cumulative effect of lower incidence rates among IDUs is evident, while among other target population groups, the impact is relatively constant throughout the period.

Figure 24: New HIV infections avoided per annum by population groups, NSW 1980-2005.



Given the reduced incidence rate attributed to the prevention initiatives, the number of people living with HIV/AIDS (PLWHA) is much lower than would otherwise have existed both during the period of the Program to date, and into the future. As indicated in Table 14 (see Section 2.5.6 and Appendices B and C), the number of people living with HIV/AIDS at the end of 2005 was estimated to be 7,587, compared to 50,276 under a "no intervention" model, a reduction of 42,680 cases. Figure 25 illustrates the reduction in the number of people living with HIV/AIDS during the period to date and into the future for each of the population groups studied until the cohort has died. This analysis takes no account of future prevention initiatives and their effects, but relates solely to the impact of the Program to the end of 2005.

Figure 25: Number of people who would otherwise have been living with HIV/AIDS by population groups, NSW 1980-2090.



3.4.2 FUTURE ACTIVITIES

As reported in Section 2.5.5, a separate set of incidence projections was prepared by NCHECR for the HIV epidemic between 2006 and 2016, to assess the impact of terminating existing prevention intervention initiatives implemented under the Program. Under the assumptions regarding the impact of cessation of these initiatives on risk behaviours among the various population groups, HIV incidence increases among all groups, particularly injecting drug users. The results are illustrated in Figures 16 to 19 (see Section 2.5.5 and Appendices D and E).

Overall, an additional 9,143 cases of HIV are estimated would occur between 2006 and 2016 if the current prevention initiatives were to cease at the end of 2005. This would result in an additional 9,079 people living with HIV in 2016, with an associated increase in clinical care costs for the remainder of their lifetime.

3.5 CLINICAL CARE COSTS

The methodology for determining the financial impact of the NSW HIV/AIDS Program examines the direct lifetime costs of clinical care for HIV/AIDS that NSW Health would have incurred, had it not been for the prevention activities funded under the Program. In essence this entails applying standard unit clinical care costs to the 44,545 cases estimated as having been avoided to the end of 2005, until that cohort has died.

3.5.1 UNIT CLINICAL CARE COSTS

Direct clinical care costs for HIV/AIDS have been based on the costs used in the previous study by Health Outcomes International and NCHECR (HOI, NCHECR, et al. (2002)), adjusted to 2005/06 prices. Costs included in the analysis include:

- Medical practitioner costs;
- Diagnostic and monitoring laboratory costs;
- Ambulatory and outpatient costs; and
- Hospital inpatient costs.

These costs have been estimated by stage of disease, and applied to the number of persons living each year at each stage of disease, until all members of the cohort have died (estimated to be in 2090). Provision was also made for the impact that the introduction that HAART had on stabilising clinical care costs.

Two adjustments have been made to the clinical care costs used in the previous study, both of which relate to costs that are met by the Commonwealth, rather than NSW Health. Firstly, we have excluded the costs of highly active antiretroviral treatment (HAART), as these costs are met by the Commonwealth, not by NSW Health. Secondly, we have included only 50% of the medical practitioner costs in the analysis, and excluded the remaining 50% on the basis that these would be met by Medicare. All remaining costs have been assumed to be met by NSW Health, and hence any such costs avoided represent the financial return to the NSW government on investment from the prevention funds invested by the NSW government under the Program.

3.5.2 CLINICAL CARE COSTS AVOIDED

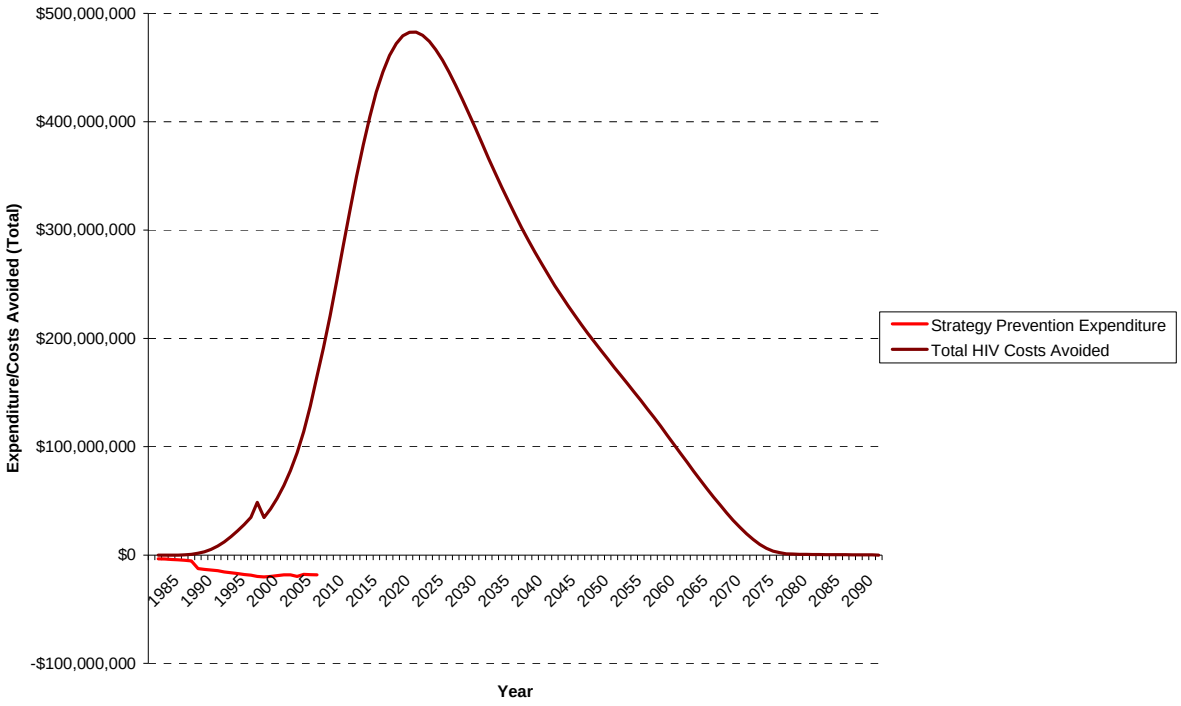
Total direct costs of clinical care avoided as a result of the HIV/AIDS Program have been estimated at $18,027 million (2005/06 prices, undiscounted) over the lifetime of these cases. Of these costs, $964 million were avoided by the end of the investment period, namely 2005. Details for each of the population groups studied are presented in Table 18.

Table 18: Lifetime costs of HIV/AIDS treatment avoided by HIV/AIDS Program, NSW 1980-2090 (2005/06 prices, undiscounted).

Group	To 2005 ($ million)	To 2090 ($ million)
MSM	$552.3	$3,872.9
IDU	$323.0	$13,454.6
HTR	$82.8	$661.4
CSW	$6.2	$37.7
Total	**$964.2**	**$18,026.6**

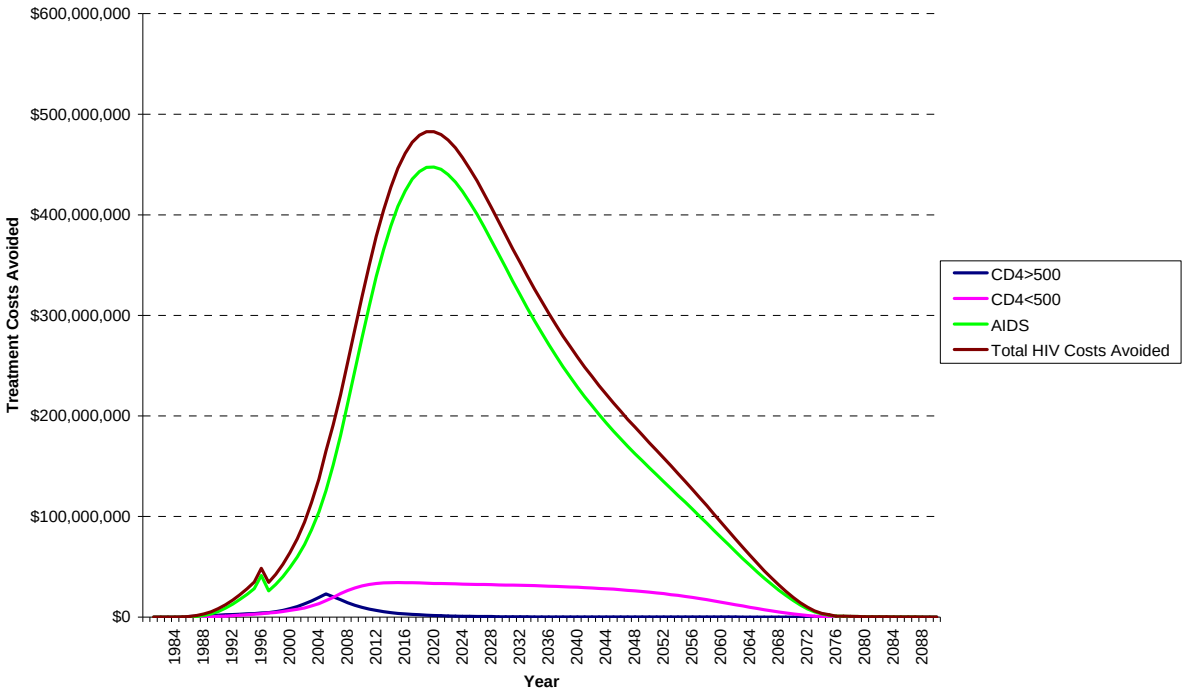
The timing of these estimated cost savings is illustrated in Figure 26, which also presents the funds invested in prevention initiatives under the NSW HIV/AIDS Program to 2005. Annual cost savings are expected to peak in 2020 at approximately $483 million, and decrease thereafter as mortality reduces the number of survivors.

Figure 26: Annual clinical care costs avoided by HIV/AIDS Program, NSW 1980-2090 (2005/06 prices, undiscounted).



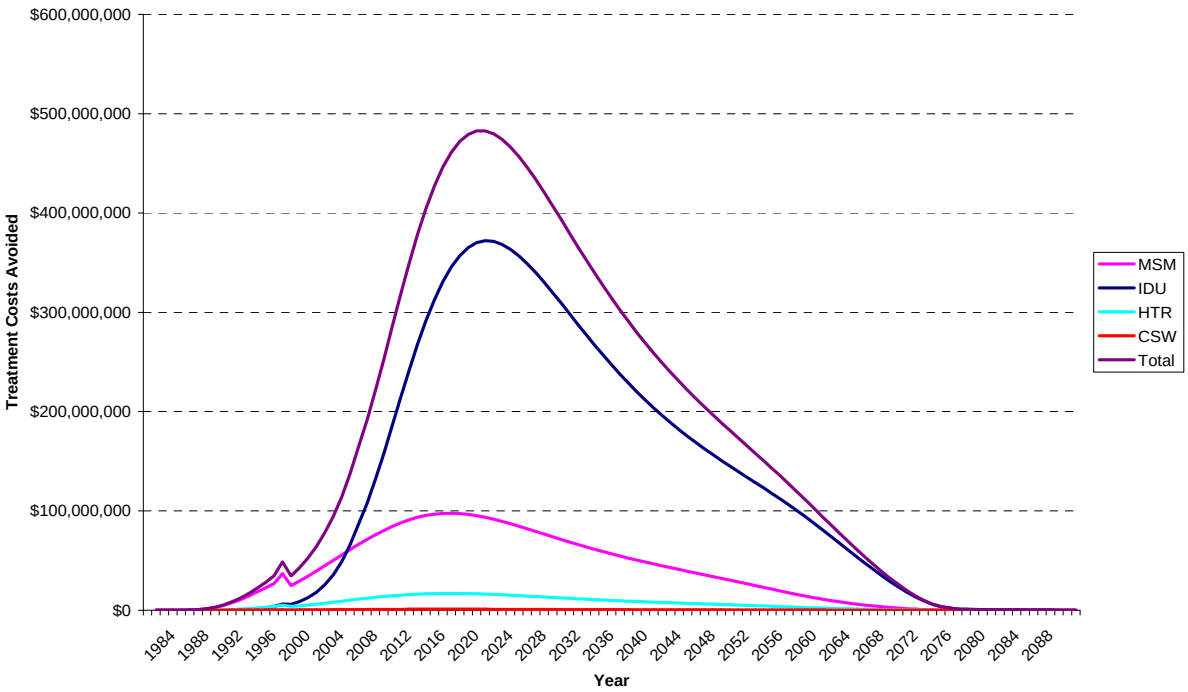
As illustrated in Figure 27, the clinical care of AIDS accounts for the large majority (89%) of these costs.

Figure 27: Annual clinical care costs avoided by stage of disease, NSW 1980-2090 (2005/06 prices, undiscounted).



Clinical care costs avoided by each of the population groups studied are presented in Figure 28. As expected, given the large number of injecting drug users estimated to have avoided HIV as a result of the investment in needle and syringe programs, this group accounts for the majority (75%) of the clinical care costs avoided, followed by homosexual men (22%), heterosexual contact (4%), and clients of commercial sex workers (0.2%)

Figure 28: Clinical care costs avoided by population groups, NSW 1980-2090 (2005/06 prices, undiscounted).



3.6 NET PRESENT VALUE ANALYSIS

As described in Section 3.2, Net Present Value (NPV) analysis seeks to compare the funds invested in an initiative with the returns that results from that investment using a common unit of measurement. This is achieved by applying an agreed discount rate to the various cashflows (inflows and outflows) that relate to the activities associated with the investment. Under this decision rule, a project is potentially worthwhile (or viable) if the NPV is greater than zero; i.e. the total discounted value of benefits is greater than the total discounted costs.

In this study, costs relate to the funds invested in the HIV/AIDS Program, while benefits relate to the lifetime costs of clinical care avoided by NSW Health as a result of its prevention initiatives.

Typically, investments that are regarded as having higher risks require higher discount rates. The discount rate most commonly used in government programs of this nature is 5% per annum. For the purposes of illustration, we have also applied discount rates of 3% and 7%.

3.6.1 MEDIUM ESTIMATES

The results of the NPV analysis for the medium set of projections prepared by NCHECR (wherein 50% of the estimated reduction in HIV incidence is attributed to the prevention initiatives under the NSW HIV/AIDS Program) are presented in Table 19.

Table 19: Net Present Value of the investment in NSW HIV/AIDS Program to 2005. ($ million)

Group	Investment in Prevention (Undiscounted)	Clinical Care Costs Avoided (Undiscounted)	Net Present Value			
			Undiscounted	Discount Rate 3%	Discount Rate 5%	Discount Rate 7%
MSM	$78.2	$3,872.9	$3,794.7	$1,171.9	$600.3	$330.2
IDU	$203.7	$13,454.6	$13,250.9	$3,288.1	$1,429.7	$654.5
HTR	$52.9	$661.4	$608.5	$169.8	$78.7	$37.7
CSW	$20.6	$37.7	$17.1	-$0.8	-$3.4	$-3.9
Total	**$355.4**	**$18,026.6**	**$17,671.2**	**$4,628.9**	**$2,105.3**	**$1,018.5**

The analysis reveals that for an investment of $355 million between 1981 and 2005, a total of $18,027 million in clinical care costs will be avoided over the lifetime of those persons who were not infected with HIV because of the preventative programs. The Net Present Value (NPV) of these savings at a discount rate of 5% is $2,105 million for the Program as a whole. The NPV is positive for three of the four components (homosexual transfer, injecting drug use and heterosexual contact), but is negative (-$3.4 million) for commercial sex worker contact. These results hold true for alternative discount rates of 3% and 7%.

Overall, the analysis demonstrates that the present value of the lifetime costs of clinical care for cases of HIV avoided under the Program exceeds the present value of the amount invested in the preventative initiatives of the Program at a range of discount rates. Thus, the Program meets the financial investment criteria at the various discount rates applied.

As would be expected, the size of the Net Present Value for each component is broadly consistent with the number of cases estimated to have been avoided for each population group, as the costs of treatment avoided are proportional to the number of clients in each group.

The NPV for commercial sex workers is the exception to achieving a positive value in the analysis. However, the comments in Section 2.5.4 regarding the difficulties in estimating potential transmission rates among this population should be taken into account when interpreting these results. In particular, the potential for underestimating the effectiveness of the Program among this population due to the exclusion of secondary transmission to the broader heterosexual

population may also lead to an underestimate of the economic impact of the investment in these preventative activities.

3.6.2 SENSITIVITY ANALYSIS

As discussed in Section 2.4 the model developed by NCHECR in this study takes into consideration the natural population-driven changes in risk behaviour that occur independent of intervention efforts, which impact on the incidence of HIV. For this reason, the medium estimates of effect of the interventions (which underpin the above estimates of NPV) assume that the interventions account for 50% of the change in behaviour and its associated impact on HIV incidence. Note, however, that this did not apply to the IDU population, where the availability of needle and syringe programs was seen as either being present or absent, and hence the availability of these services accounted for all the observed change for this population. For other target groups, sensitivity analysis was conducted that produced estimates for an upper and lower effect, based on the interventions changing risk levels by 75% and 25% respectively. The application of these rates to the Net Present Value analysis produced the results presented in Table 20. For the sake of completeness, we have included data for the IDU group at the medium level for both sensitivity analyses.

Table 20: Sensitivity analysis of NPV of investment in NSW HIV/AIDS Program to 2005.

Group	Net Present Value ($ million)			
	Undiscounted	Discount Rate 3%	Discount Rate 5%	Discount Rate 7%
Lower Estimates of Effect of Program				
MSM	$1,392.3	$421.1	$210.7	$112.2
IDU	$13,251.0	$3,288.1	$1,429.7	$654.5
HTR	$211.6	$48.6	$16.9	$3.8
CSW	-$1.8	-$7.0	-$6.7	-$5.8
Total	**$14,853.0**	**$3,750.8**	**$1,650.6**	**$764.7**
Upper Estimates of Effect of Program				
MSM	$7,386.0	$2,282.1	$1,171.8	$647.3
IDU	$13,251.9	$3,288.1	$1,429.7	$654.5
HTR	$1,196.4	$346.7	$168.0	$86.2
CSW	$35.9	$5.3	$0	-$2.0
Total	**$21,689.2**	**$5,922.2**	**$2,769.4**	**$1,386.0**

The table illustrates that for the lower impact scenario, the Net Present Value of the prevention initiatives of the Program as a whole remains positive at all discount rates. The NPV is positive for three of the four components (homosexual transfer, injecting drug use and heterosexual contact) at all discount rates. The NPV for commercial sex workers is negative at all discount rates under this scenario. Thus the results for the lower estimates of effect of the Program are consistent with those for the medium estimates.

For the higher impact scenario, the Net Present Value is greater for the Program as a whole and for all components. Under this scenario, the NPV for commercial sex workers becomes positive at the 3% and 5% discount rates, but remains negative at the 7% discount rate. Thus under the higher estimate scenario, the Program and all its component elements meet the investment criteria at the 3% and 5% discount rates.

The sensitivity analysis thus illustrates that the results achieved are sensitive to both the degree of attribution of effect of the prevention initiatives on risk behaviours, as well as the discount rate used in calculating the NPV. A positive NPV is achieved for the Program as a whole under all scenarios. However, whilst three of the components of the Program demonstrate positive NPVs

under all assumptions and scenarios, commercial sex worker contact yields positive and negative NPVs under different scenarios, due largely to the low numbers.

3.7 LIFE AND QUALITY OF LIFE IMPACTS

HIV is a potentially life-threatening condition, hence one of the main benefits from averting infections is the prevention of premature mortality. Since the introduction of highly active antiretroviral therapy (HAART) in 1996, HIV disease progression has markedly slowed, both prior to and following the development of AIDS, resulting in a longer life expectancy. Morbidity and mortality associated with AIDS illnesses have also declined by 50-80% in settings where access to HAART is readily available. In recognition of these effects, this study has therefore examined the impact of the preventative initiatives under the Program on the number of life years gained associated with reduced mortality.

HIV/AIDS also has a wide range of physical symptoms (with direct effects on the person's quality of life) as well as a range of psychosocial effects among infected persons, some of which may be associated with discrimination and social stigma. These also impact on the person's quality of life, regardless of whether the disease progresses or not. Consequently, it is likely that gains in quality of life are one of the major health benefits of the prevention of HIV infections, and have also been considered in this study.

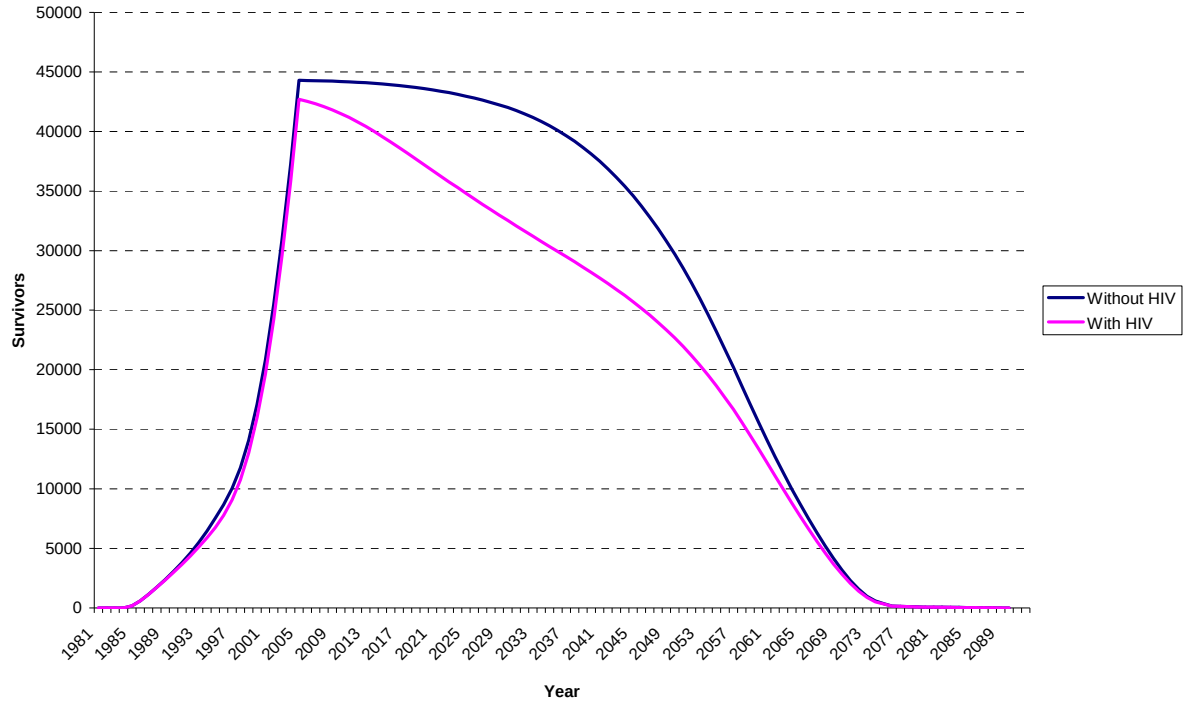
3.7.1 LIFE YEARS GAINED

The number of life years gained provides a measure of the additional number of years gained by those persons who would otherwise have been infected with HIV, but for the effect of preventative initiatives under the Program. This has been estimated by deducting the number of life years they would have lived with HIV from the number of years they are estimated to live without the disease. The results are indicative of the effect of the mortality rate for HIV on the various sub-populations, compared to that for the same population without these diseases.

The analysis indicates that a total of 394,307 life years will be saved over the lifetime of those persons avoiding HIV as a result of the preventative initiatives of the Program, representing an additional 9 years of life per case avoided.

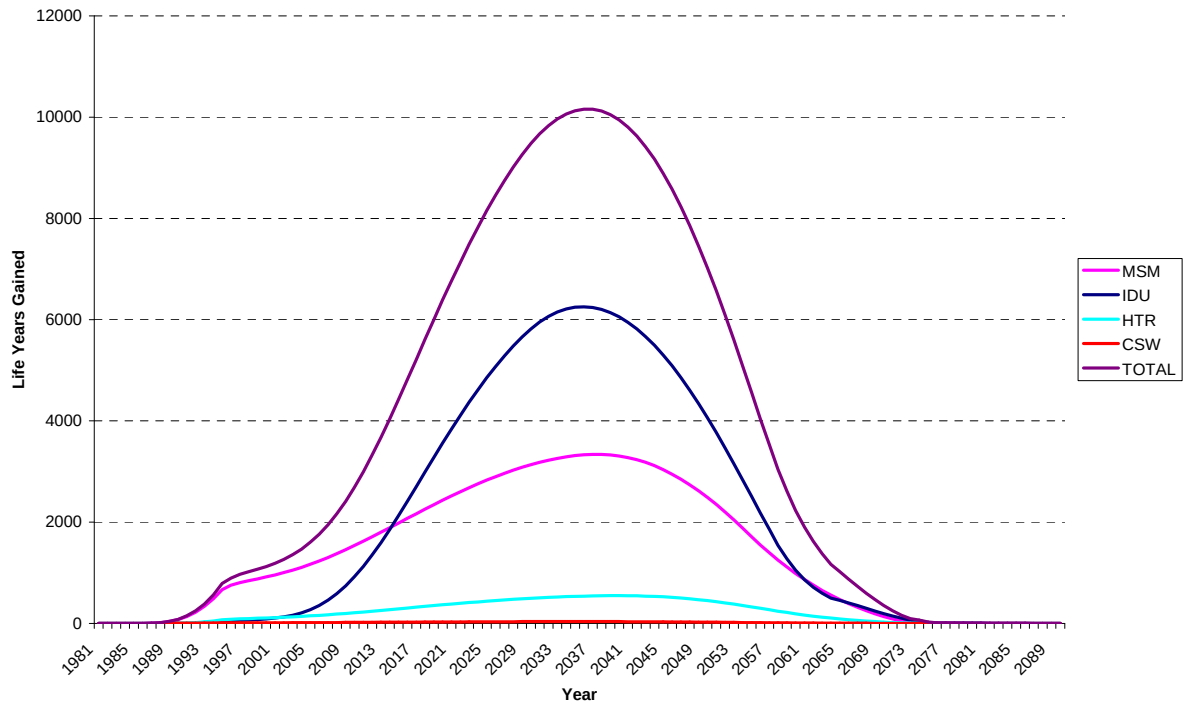
The distribution of expected survival rates with and without HIV over the lifetime of the cohort of persons avoiding HIV is illustrated in Figure 29.

Figure 29: Life years of persons avoiding HIV, NSW 1980-2090.



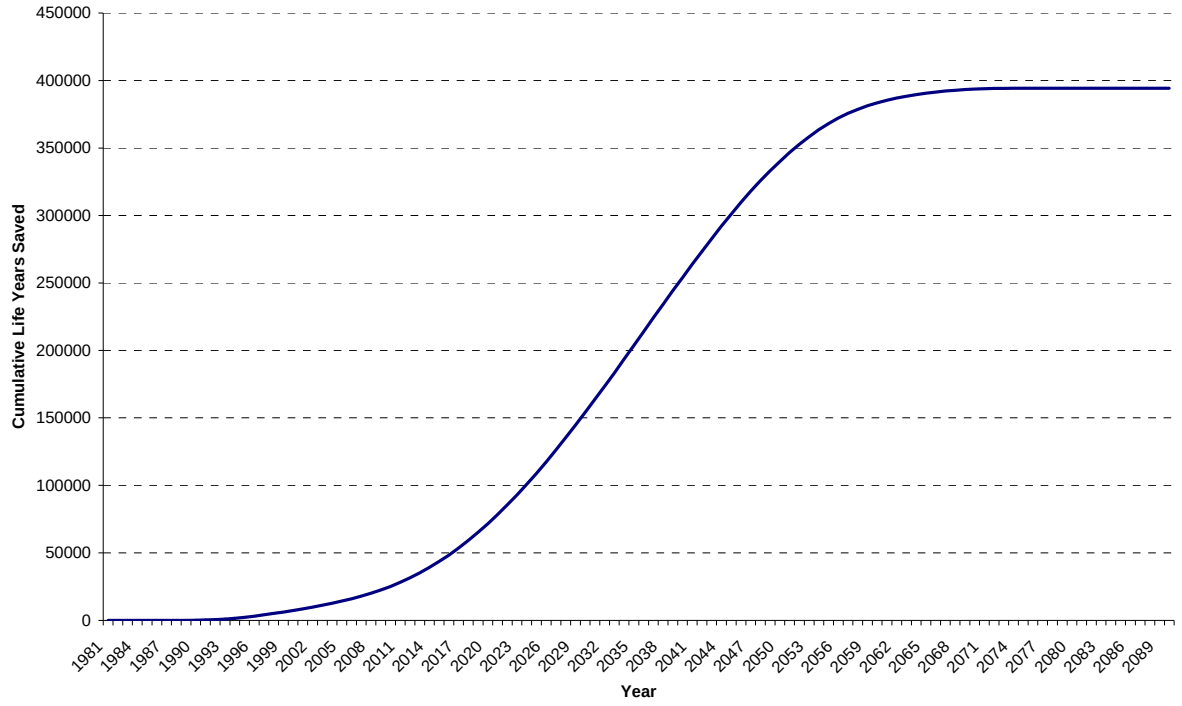
The annual gain in life years by persons avoiding HIV, both in total and among the population groups included in this study is illustrated in Figure 30. Life years saved are expected to peak at about 10,000 per annum between 2035 and 2040. Of the total life years saved, 55% relate to injecting drug users, with 38% attributed to homosexual men. Life year gains among heterosexual cases accounted for a further 6%.

Figure 30: Life years gained by population groups, NSW 1980-2006.



The cumulative gain in life years saved (represented by the gap between the two survival curves presented in Figure 29) is illustrated in Figure 31.

Figure 31: Cumulative life years gained by persons avoiding HIV, NSW 1980-2090.



3.7.2 QUALITY OF LIFE IMPACTS

The measurement of quality of life impacts of different preventative and treatment programs has been the subject of considerable debate for many years (see for example, Drummond et al, 2005). Two of the measures commonly used in economic evaluation are Quality Adjusted Life Years (QALYs) and Disability Adjusted Life Years (DALYs).

In QALYs, states of health are assigned a 'health state preference' or 'utility' value, on a scale from 0 (death) to 1.0 (full health). The amount of time an individual spends in a given health state is then multiplied by the health state preference value to calculate the quality-adjusted life-years (QALYs) associated with that health state. The QALYs gained from a given health care intervention are estimated by considering the difference in progression through the various health states, with and without the intervention concerned. The main advantage of the QALY approach is that it provides one combined measure of the benefits of a program that both extends life and has an impact on quality of life.

DALYs were developed by the World Health Organisation (WHO) for use in the Global Burden of Disease and Injury study with the aim of quantifying the burden of disease and injury on human populations. The burden of disease is measured in terms of DALYs lost in comparison to an ideal healthy life with a quality score of 1.0 and a longevity equal to that of the country with the longest life expectancy (Japan). There are two elements to the DALY measure – years of life lost (YLL) due to premature death and equivalent years of health life lost due to disability (YLD). A DALY is the sum of these two components.

Whilst DALYs are conceptually similar to QALYs, there are a number of differences between the two measures, including (as described in Drummond et al, 2005):

- The life expectancy used in the QALY depends on the situation, whereas the life expectancy used in the DALY is constant;

- The disability weights used in the QALY are based on preferences, either those of the general public or those of patients in the study. The disability weights used in the DALY are not preferences, but are person trade-off scores from a panel of health care workers.
- Although both sets of disability weights are on the same scale, where death has a score of 0 and full health has a score of 1, QALY weights may take on any value depending on the health state, while DALY weights can take on only one of 7 discrete values.
- The QALY does not use age weights, whereas the DALY uses age weights that give lower weight to years of the young and the elderly.

For the purpose of this study, we have used QALYs as the measure of impact on quality of life among the HIV cases avoided by the preventative initiatives undertaken under the NSW HIV/AIDS Program. This approach is also consistent with the previous study into the economic impact of Needle and Syringe Programs in Australia.

3.7.3 QUALITY-ADJUSTED LIFE-YEARS (QALYS)

With HIV, we would expect that the health state values for early stages of disease, such as early HIV (CD4 count above 500/mm^3), are higher than those for the later stages of disease, such as AIDS. Therefore, if the various preventative initiatives reduce the probability of infection, or increase the average time to infection, we would expect fewer individuals in a cohort of persons at risk to progress to the later stages of disease during their lifetime. Under the QALY approach this will lead to QALY gains.

QALY VALUES FOR HIV

The duration of time spent in particular health states for people with HIV has been estimated from the epidemiological literature and Australian data. These were incorporated into the calculation of the number of cases prevented by stage of disease and the projections of survivors beyond 2005, as outlined in Section 2, and summarised Appendices B and C.

Health state preference values were drawn from the extant literature e.g. Tengs et al (2000) report more than 1,000 utility values, many of which relate to HIV. There have also been a number of papers published specifically relating to HIV (e.g. Holtgrave and Pinkerton, 1997). The values used in this study are consistent with those used in the previous study of NSP programs by Health Outcomes International and NCHECR (HOI, NCHECR, et al. (2002)). Definitions for disease states and associated quality of life adjustments for HIV are presented in Table 21.

Table 21: Quality of life values by disease stage of HIV.

Disease Stage	Description	QALY Value
Early HIV Disease – Undiagnosed.	HIV infection with CD4 count above 500/mm^3, unaware of HIV serostatus.	0.94
Early HIV Disease – Diagnosed.	HIV infection with CD4 count above 500/mm^3, aware of HIV serostatus and no antiretroviral therapy.	0.87
Progressive HIV Disease – Undiagnosed.	HIV infection with CD4 count below 500/mm^3, unaware of HIV serostatus.	0.90
Progressive HIV disease – Diagnosed.	HIV infection with CD4 count nadir below 500/mm^3 and commenced on antiretroviral therapy.	0.76
AIDS	AIDS as defined by clinical condition.	0.62

Although somewhat more controversial than discounting financial costs and benefits, it is also conventional to discount QALYs by the same rate. This has the effect of reducing the estimate of

the total QALYs gained, as many of the QALYs are gained in the future. The results are presented in the following section.

QUALITY ADJUSTED LIFE YEARS GAINED

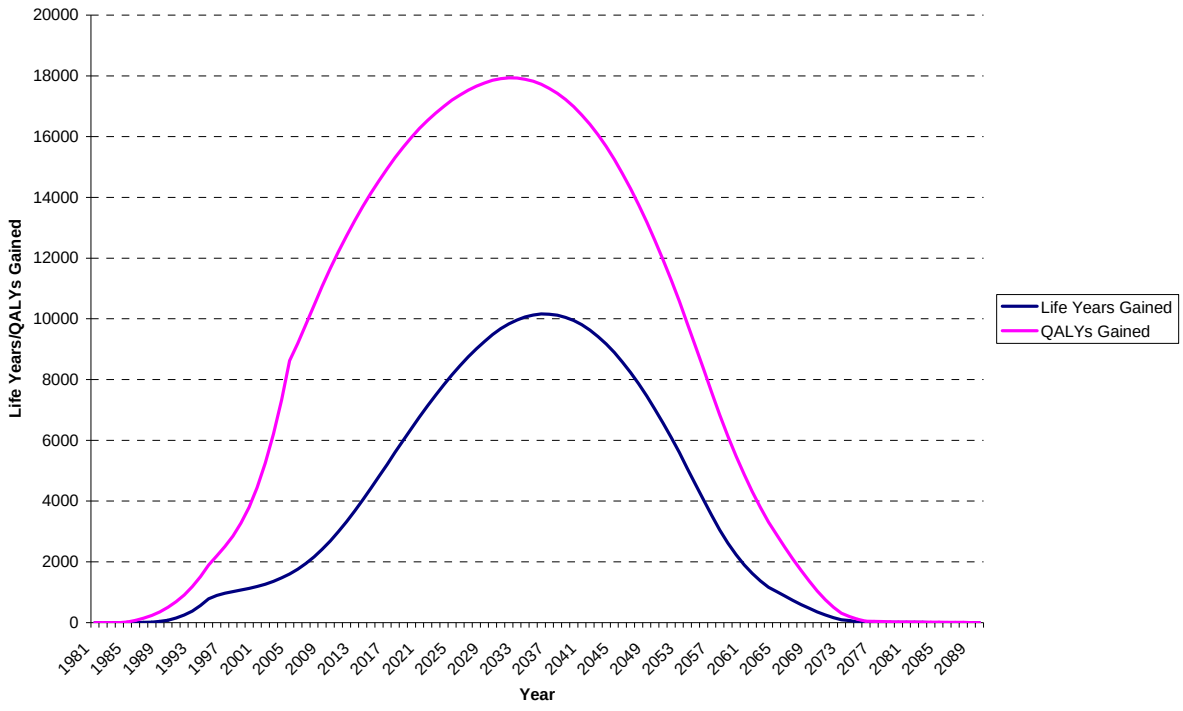
The estimates of the number of cases of HIV avoided as a result of the preventative initiatives implemented under the Program are summarised in Table 17 (Section 3.4) and in Appendices B and C. The outcomes in regard to life years saved have also been illustrated previously in Figures 29 and 30.

In summary, approximately 44,500 cases of HIV infection are estimated to have been avoided as result of the preventative initiatives implemented between 1980 and 2005. By the year 2010, some 2,750 deaths from HIV are estimated as being avoided. As illustrated in Section 3.7, over the lifetime of the cases of HIV avoided, a total of approximately 394,000 additional life years are estimated to be gained.

However, the above analysis does not take into account the differences in the quality of life for those with HIV compared to those without the disease. The application of the 'utility' values described above to take account of the quality of life effects of HIV/AIDS leads to the calculation of Quality Adjusted Life Years (QALYs). Comparing this measure to the number of life years that the affected population lives in a disease-free state (i.e. by avoiding HIV) provides a measure of the QALYs gained as a result of the Program's prevention initiatives.

Figure 32 illustrates the number of life years and the QALYs gained by the 44,500 persons who are estimated to have avoided HIV under the Program.

Figure 32: Quality Adjusted Life Years gained by persons avoiding HIV, NSW 1980-2090.



A total of 862,880 QALYs are estimated to be gained through the avoidance of HIV under the Program. QALY gains peak between 2025 and 2040 at 17,000 to 18,000 per annum. The area between the two curves represents the quality of life gain resulting from avoiding HIV, and is of a similar order of magnitude as the total life years gained. This illustrates the significant impact that HIV/AIDS has on quality of life. As illustrated in Figure 33, injecting drug users account for 67% of total QALYs gained, with homosexual men accounting for a further 29%.

Figure 33: Quality Adjusted Life Years gained by population groups, NSW 1980-2090.

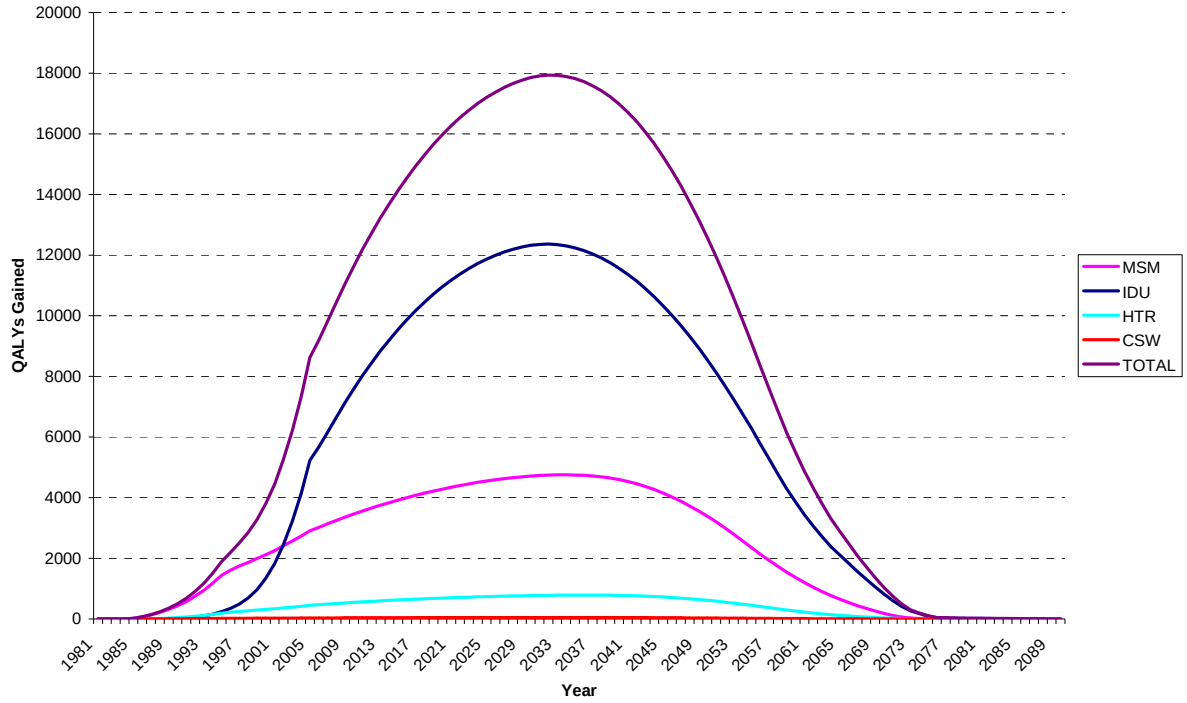
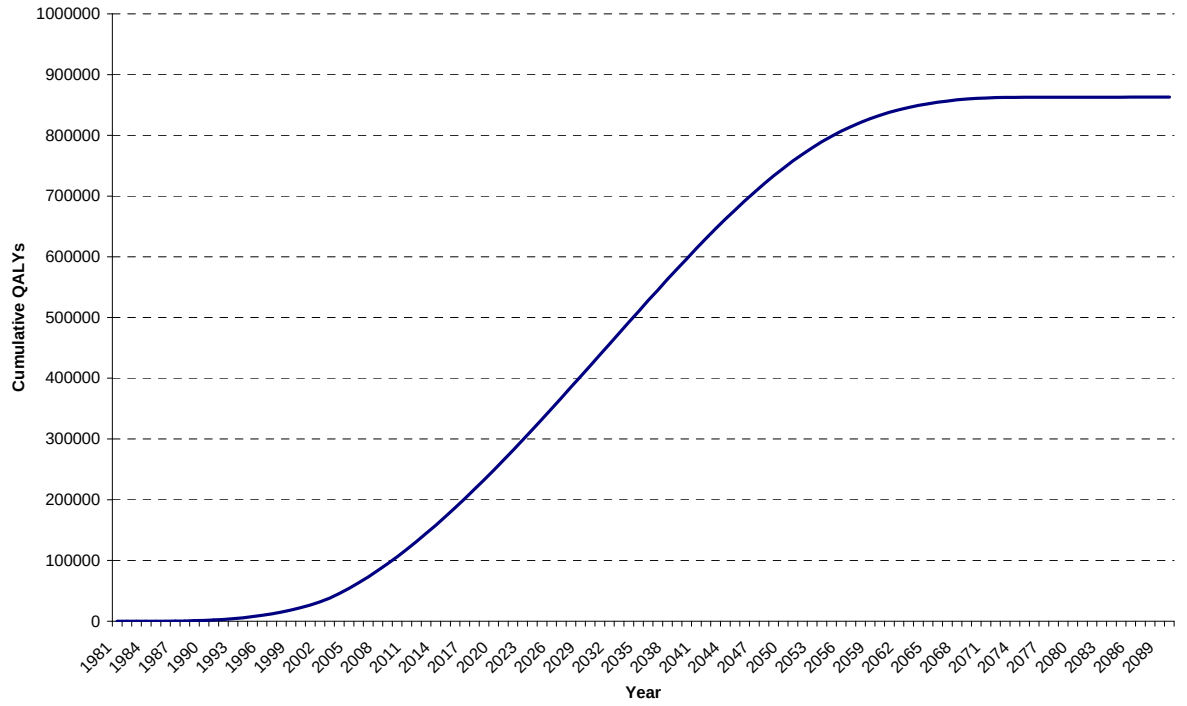


Figure 34 illustrates the cumulative distribution of 863,000 QALYs gained.

Figure 34: Cumulative QALYs gained by persons avoiding HIV, NSW 1980-2090.



As previously noted, it is common to discount QALYs gained in the future in the same way as discounting financial benefits. This approach is based on the principle that an improvement in the quality of life is likely to be valued more if it occurs earlier than if it occurs later in life. Applying the same discount rates used in the financial analysis (i.e. 7%, 5%, 3% and undiscounted) to QALYs gained results in the figures shown in Table 22.

Table 22: Net Present Value of QALYs gained, NSW 1980-2090.

Discount Rate	Net Present Value (QALYs)
7%	49,584
5%	98,420
3%	215,119
Undiscounted	862,880

A total of approximately 863,000 QALYs are estimated to be gained by the avoidance of HIV, the present value of which at a discount rate of 7% is 50,000 QALYs (98,000 at 5%, and 215,000 at a 3% discount rate).

Discounting has the effect of reducing the present value of gains made in later years relative to those made in earlier years. Consequently, the ratio of the present value of QALYs gained to total QALYs gained for HIV 11% at a discount rate of 5%) illustrates that a significant proportion of the QALY gains are in the latter years of life, particularly through the avoidance/deferral of AIDS.

3.8 DISCUSSION

The analysis of the impact of the NSW HIV/AIDS Program has examined both the financial impacts (in terms of the costs of clinical care avoided by NSW Health over the lifetime of cases) as well as the impact on the quantity of life and the quality of life of persons who would otherwise have contracted HIV.

As described in Section 3.3, estimated total expenditure on the Program between 1980 and 2005 was $1,259 million ($1,606 million, undiscounted, 2005/06 prices). Of this, 70% was allocated to clinical care services and 30% to preventative initiatives. Estimates of the allocation to specific target populations have been based on data provided by NSW Health, with a total of $355 million (undiscounted, 2005/06 prices) allocated to the four population groups studied in this analysis.

Section 3.5 provides estimates of the clinical care costs avoided by NSW Health over the lifetime of these cases, which are estimated at $18,027 million (undiscounted, 2005/06 prices). Injecting drug users account for 75% of these savings, with 22% accrued by homosexual men.

The analysis of the Net Present Value of the investment in the Program, presented in Section 3.6, illustrates that the Program has met the financial investment criteria in regard to clinical care costs avoided alone, without considering the impacts on quantity and quality of life. The results are sustained under a range of alternative assumptions tested in sensitivity analyses.

When the impact on quantity and quality of life are taken into consideration, the analysis (see Section 3.7) indicates that a total of approximately 394,000 life years are gained over the lifetime of persons avoiding HIV. Of the total life years saved, 55% relate to injecting drug users, with 38% attributed to homosexual men. Life year gains among heterosexual cases account for a further 6%. In regard to the impact on quality of life, an estimated 863,000 Quality Adjusted Life Years are gained. The Present Value of these QALYs at a discount rate of 5% (i.e. the value placed on them at the beginning of the investment period) was 98,000 QALYs.

A comparison has been made of the outcomes of this study with other public health preventative initiatives. It should be noted that caution needs to be exercised in this process, as the different initiatives may use different outcome measures, have been in operation for different periods, and the timeframes over which the effects of the programs are realized may also differ.

A study commissioned by the Department of Health and Ageing (DHA) in 2003 titled "Returns on Investment in Public Health: An epidemiological and economic Analysis" examined the economic benefits of public health programs in Australia that sought to reduce tobacco

consumption, coronary heart disease, HIV/AIDS, measles and Hib disease, and road trauma. We have compared the results for the first two of these programs (tobacco and coronary heart disease) with those from the current study.

In the DHA studies, the economic analysis covered the period 1971 to 2010, using DALYs as the measure for quality of life effects (see Section 3.7.2 for an explanation of DALYs). As previously noted, QALYs were used as the measure for quality of life effects in the NSW HIV/AIDS review, which is not directly comparable to the DALY measure. However, in the DHA study of HIV/AIDS, it estimated that on average, one HIV infection resulted in 44.0 DALYs (undiscounted), or 11.4 DALYs when discounted at a 5% discount rate (comprised of 7.9 YLLs and 3.5 YLDs). We have applied these scores to the 44,545 infections estimated to have been avoided by the NSW HIV/AIDS Program in this study, resulting in an estimated 507,817 DALYs saved. The DHA studies valued a DALY at $60,000 (discounted at 5%), which was then applied to the above estimate for the purpose of comparison of outcomes on a common basis between the three studies. The results are summarized in the following tables:

Table 23: Comparison of economic impacts of three Public Health Programs. ($ million, discounted at 5%)

Study	Investment	YLLs	YLDs	DALYs	Care Costs Saved	Total Benefits	Net Benefits
DHA - Tobacco	$176	$6,710	$1,548	$8,258	$344	$8,602	$8,426
DHA – Heart Disease	$810	$7,710	$1,022	$8,732	$557	$9,289	$8,479
NSW – HIV/AIDS	$173	$21,114	$9,355	$30,469	$2,278	$32,747	$32,574

As noted previously, any direct comparison of the above data needs to be undertaken cautiously, particularly in regard to their absolute values. However, there are several key ratios that assist in overcoming these difficulties, as presented in the following table:

Table 24: Comparison of key ratios in the economic analysis of three Public Health Programs.

Study	% of Total Benefits				Care Costs Saved: Investment	Total Benefits: Investment
	YLLs	YLDs	DALYs	Care Costs Saved		
DHA - Tobacco	78%	18%	96%	4%	2:1	49:1
DHA – Heart Disease	83%	11%	94%	6%	0.7:1	11:1
NSW – HIV/AIDS	65%	29%	93%	7%	13:1	189:1

Across all studies, direct care cost savings comprise 4-7% of total benefit, while life years saved and quality of life gains account for 93-96% of total benefits.

When comparing direct care costs saved relative to funds invested, for both the tobacco reduction program and the NSW HIV/AIDS program, direct care costs saved exceed the value of the funds invested. The ratio of direct cost savings to investment for tobacco reduction programs is 2:1 compared to 13:1 for the NSW HIV/AIDS Program. For heart disease, the direct cost savings were about 70% of the investment (i.e. the cost savings were less than the investment).

When comparing total benefits from each of the initiatives, the overall ratio of benefits to investment was positive for all programs, ranging from 11:1 for heart disease, to 49:1 for tobacco, to 189:1 for the NSW HIV/AIDS Program.

Thus across all key indicators, the NSW HIV/AIDS Program is assessed as providing greater returns on the funds invested in regard to direct care costs saved and total benefits derived.

4

DISCUSSION AND CONCLUSIONS

4.1 OVERVIEW

The NSW HIV/AIDS Program has been an important component of the response to the HIV epidemic in Australia since the early 1980s. This report provides an overview of the impact of the HIV/AIDS epidemic in NSW to date and projects the future impact of HIV/AIDS in NSW. This encompasses an economic impact of the epidemic in regard to direct care costs avoided, the NSW investment in the public health response to HIV/AIDS and the morbidity and mortality arising from HIV/AIDS.

The NSW HIV/AIDS Program was established in 1984 and encompasses primary and secondary prevention, and care, treatment and support for people living with HIV/AIDS. The NSW HIV/AIDS Strategy articulates the framework for collaboration between government, affected communities, researchers and medicine, and seeks to ensure that programs and services are informed by both the best available evidence and the experience of those living with or at risk of HIV infection.

4.2 HISTORICAL TRENDS

The analysis of historical trends of HIV incidence and prevalence undertaken by NCHECR as part of this study found that the number of people with a newly diagnosed HIV infection decreased between 1995 and 2001. Since the nadir of 2001, HIV incidence increased to 2003 and has effectively plateaued since then. Approximately 65% of people with HIV reported primary exposure through male-to-male sexual contact.

The number of diagnoses of newly-acquired HIV infections (defined as new HIV diagnoses with either a previous HIV-negative test within the previous 12 months or with evidence of recent seroconversion) declined in the mid-1990s, concurrent with the availability of combination antiretroviral treatment, but again there is some evidence of an increase in numbers since 2002.

Both AIDS diagnoses and deaths peaked in 1994 in NSW, with large declines from 1996 onwards with the availability of combination antiretroviral treatment. This pattern was consistent across most exposure categories, except AIDS diagnoses in people with HIV-infection through heterosexual contact. AIDS diagnoses in this group showed little decline through the 1990s, largely associated with late HIV-diagnosis in this group.

4.3 EPIDEMIOLOGICAL MODEL

The study has examined the incidence and prevalence of HIV in four identified population groups, namely homosexual men, injecting drug users, the general heterosexual population, and commercial sex workers. These populations represent some of the key priority population groups identified for the Program for which data are available to support the analysis. Due to limited data, explicit modelling of epidemics by indigenous status or ethnicity was not attempted, although migrants from high HIV prevalence countries were included as a part of the modelling of heterosexual transmission.

For each of the study population groups, we examined historical trends in HIV transmission and the risk factors that affect the transmission of HIV. Based on this analysis, models were developed that compare a baseline scenario (reflecting actual HIV transmission rates to date with preventative strategies in place) with modelled alternative scenarios that assume that no intervention strategies were in place, other than antiretroviral therapy. Projections were then made that estimate the number of people living with HIV/AIDS under each scenario from 2005 to 2090, by which time all survivors are estimated to have died. In scenarios where intervention measures for sexual transmission of HIV were absent, it was assumed that the absence of intervention measures accounted for 50% of the estimated change in levels of risk. This takes into consideration the natural population-driven change in risk behaviour independent of intervention efforts. Lower and upper limits of the impact of interventions on changing risk levels were set at 25% and 75%, respectively. For injecting drug users, the model assumed only the presence or absence of needle and syringe programs for its estimation of effect.

In the medium set of projections developed under these assumptions, the total number of cases of HIV avoided between 1980 and 2005 as a result of the various preventative initiatives funded under the Program was estimated at approximately 44,500 cases. Overall, this represents an estimated 80% reduction in the number of new cases of HIV that would otherwise have occurred during this period in the absence of the preventative initiatives. The estimated reduction in HIV incidence ranged from 99% among injecting drug users to 50% among those infected by homosexual contact. Injecting drug users comprised 75% of the total cases avoided, with homosexual men comprising 22%.

A separate set of projections was prepared for the HIV epidemic between 2006 and 2016, to assess the likely impact of terminating existing prevention intervention initiatives from 2005. Under the assumptions regarding the impact of cessation of these initiatives on risk behaviours among the various population groups, HIV incidence increases among all groups, particularly injecting drug users. In these projections, an additional 9,100 cases of HIV are estimated would occur from 2006 to 2016 if the current prevention initiatives were to cease at the end of 2005. This would result in an additional 9,000 people living with HIV in 2016, with an associated increase in clinical care costs for the remainder of their lifetime.

4.4 ECONOMIC MODEL

The economic analysis has examined the investment made by the New South Wales government in the HIV/AIDS Program since 1981, including funds allocated to preventative and clinical care services and activities, together with the clinical care costs avoided as a result of the reduced incidence of HIV associated with the preventative activities. Clinical care costs refer to the direct costs of providing medical and allied health care of HIV/AIDS via public sector facilities and via funded non-government organisations that are met by the NSW Government. These exclude the costs of antiretroviral therapy which are met by the Commonwealth and which are of the order of $10,000 per patient per annum. The NSW Government also makes a small contribution to the cost of Highly Specialised Drugs.

Based on the available data, the study has estimated that a total of $1,259 million was invested in the NSW HIV/AIDS Program between 1981/82 and 2005/06 ($1,606 million in 2005/06 prices). Approximately 70% of this investment was allocated to clinical care services, with 30% ($484 million in 2005/06 prices) allocated to preventative activities. Information provided by NSW Health provided the basis for allocating the preventative funds across various population groups, including the four groups that formed the focus of this study.

The analysis of the return on the investment in preventative activities has considered two aspects; (1) the financial value of the direct lifetime costs of clinical care of HIV avoided by NSW Health, and (2) the life years and quality adjusted life years saved as a result of the preventative activities funded under the Program.

The financial return on investment found that a total of $18,027 million (in 2005/06 prices) in clinical care costs that would otherwise be borne by the NSW Government would be saved over

the lifetime of the HIV cases avoided by the prevention initiatives funded under the Program. Annual cost savings are expected to peak in 2020 at approximately $483 million, and decrease thereafter as mortality reduces the number of survivors. Of these savings, 75% relate to injecting drug users, 22% to homosexual men, and 4% to the heterosexual population. A total of $38 million in clinical care cost savings are attributed to the commercial sex work group.

Discounting both the investment expenditure and the lifetime costs of clinical care avoided to a common value (the Net Present Value (NPV)) reveals that the HIV/AIDS Program has achieved a positive NPV, indicating that it fulfils the financial expectations of the Program. At a discount rate of 5%, the NPV of the investment made under NSW HIV/AIDS Program to 2005/06 was estimated at $2,105 million. The ratio of clinical care costs avoided to funds invested by the NSW government is approximately 13:1, meaning that for every $1 expended on HIV prevention programs, clinical care cost savings of $13 are achieved. The return on the preventative components of the HIV/AIDS Program alone was sufficient to offset the total investment in both clinical care and preventative components of the Program.

Sensitivity analysis on these findings reveals that the results are sustained under both higher and lower estimates of the contribution of the prevention initiatives to the overall reduction in HIV.

The second component of the economic model examined the life Years and quality-adjusted life years saved as a result of the investment in preventative initiatives. A total of approximately 394,000 life years are gained over the lifetime of persons avoiding HIV. Of the total life years saved, 55% relate to injecting drug users, with 38% attributed to homosexual men. Life year gains among heterosexual cases account for a further 6%.

In regard to the impact on quality of life, an estimated 863,000 Quality Adjusted Life Years (QALYs) are expected to be gained over the lifetime of persons who would otherwise have been infected with HIV. The Present Value of these QALYs at a discount rate of 5% (i.e. the value placed on them at the beginning of the investment period) was 98,000 QALYs.

A rudimentary comparison of these results with those for several other public health preventative initiatives aimed at reducing tobacco consumption and reducing coronary heart disease indicates that the HIV/AIDS Program compares very favorably in regard to direct health care costs saved and total benefits derived relative to the funds invested. For example, the ratio of care costs saved to funds invested for the HIV/AIDS Program is estimated at 13:1 compared to 2:1 for tobacco reduction strategies, while the ratio of total benefits to funds invested for HIV/AIDS is 189:1 compared to 49:1 for tobacco reduction strategies.

4.5 CONCLUSION

The investment in the NSW HIV/AIDS Program has been a major public health initiative, and has been in place since the early 1980s. Four specific populations targeted in the preventative initiatives funded under the program were considered in the analysis – homosexual men, injecting drug users, the heterosexual population, and commercial sex workers. The analysis of the effectiveness of the Program in each of these populations indicates that the Program has been successful, and has contributed significantly to:

- The number of cases of HIV avoided (45,000 cases avoided);
- A reduction in the number of deaths from HIV (2,750 deaths avoided by 2010);
- Avoidance of significant clinical care costs of HIV/AIDS over the lifetime of the cases avoided (estimated at $18,000 million, undiscounted);
- A positive Net Present Value in respect of the investment in preventative initiatives and the clinical care costs avoided;
- An increase in life years survived by persons who would otherwise have contracted HIV (394,000 life years saved); and
- An improvement in the quality of life among persons who would otherwise have contracted HIV (863,000 QALYs saved).

The analysis also indicates that continued investment in the preventative initiatives of the Program can be expected to continue to provide benefits in each of these areas into the future.

The study has necessarily relied on a range of data in its development and application, with estimates and assumptions made where data were not available or limited. The results indicate that no reasonable changes to the underlying assumptions or estimates used are likely to materially affect the results achieved. Nevertheless, improved data collections across a number of areas, particularly monitoring of funds invested across priority population groups, would further enhance the reliability of the results and the application of the model to other priority populations.

A

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B

MODELLED HIV INCIDENCE AND PREVALENCE, BASELINE SCENARIO, 1980-2005.

Year	Incidence	PLWHA				AIDS deaths	
		Total	CD4>500	CD4<500	AIDS	Annual	Cum.
1980	0	0	0	0	0	0	0
1981	56	56	56	0	0	0	0
1982	377	433	429	4	0	0	0
1983	1,145	1,574	1,538	34	3	2	2
1984	1,646	3,209	3,040	156	14	9	11
1985	1,372	4,552	4,076	435	41	28	39
1986	887	5,375	4,412	875	88	62	101
1987	593	5,856	4,292	1,414	150	110	211
1988	413	6,102	3,910	1,970	221	167	379
1989	352	6,226	3,456	2,475	294	227	606
1990	350	6,289	3,041	2,886	363	286	892
1991	342	6,290	2,682	3,183	425	340	1,232
1992	327	6,229	2,382	3,370	478	387	1,620
1993	312	6,115	2,138	3,457	520	426	2,046
1994	301	5,959	1,945	3,461	553	457	2,502
1995	296	5,777	1,800	3,402	575	478	2,980
1996	224	5,804	1,698	3,335	771	197	3,177
1997	211	5,893	1,607	3,405	880	121	3,298
1998	208	6,021	1,538	3,487	996	79	3,377
1999	228	6,177	1,509	3,558	1,110	70	3,447
2000	253	6,364	1,524	3,619	1,221	64	3,511
2001	278	6,573	1,571	3,680	1,322	68	3,579
2002	319	6,818	1,659	3,748	1,411	72	3,651
2003	329	7,070	1,754	3,827	1,489	75	3,726
2004	334	7,323	1,844	3,921	1,557	79	3,805
2005	339	7,577	1,928	4,032	1,617	82	3,888
2006		7,490	1,661	4,160	1,670	85	3,973
2007		7,400	1,401	4,284	1,715	88	4,060
2008		7,307	1,166	4,389	1,752	90	4,151
2009		7,212	962	4,468	1,782	92	4,243
2010		7,115	790	4,521	1,803	94	4,337
2011		7,016	649	4,551	1,816	95	4,431

Year	Incidence	PLWHA				AIDS deaths	
		Total	CD4>500	CD4<500	AIDS	Annual	Cum.
2012		6,,916	534	4,560	1,822	96	4,527
2013		6,815	442	4,554	1,819	96	4,623
2014		6,714	368	4,538	1,809	96	4,719
2015		6,613	307	4,514	1,792	96	4,814
2016		6,512	258	4,486	1,768	95	4,909
2017		6,411	218	4,455	1,739	94	5,003
2018		6,311	184	4,422	1,705	92	5,095
2019		6,212	156	4,389	1,666	91	5,186
2020		6,113	132	4,356	1,624	89	5,275
2021		6,015	113	4,323	1,579	87	5,362
2022		5,918	96	4,289	1,532	85	5,447
2023		5,822	82	4,255	1,484	83	5,530
2024		5,726	71	4,220	1,435	81	5,611
2025		5,631	61	4,185	1,385	78	5,689
2026		5,,537	53	4,147	1,336	76	5,765
2027		5,442	47	4,109	1,287	74	5,838
2028		5,348	41	4,068	1,239	71	5,910
2029		5,254	37	4,025	1,192	69	5,978
2030		5,159	33	3,980	1,146	66	6,045
2031		5,063	30	3,932	1,101	64	6,109
2032		4,966	28	3,881	1,058	62	6,170
2033		4,868	26	3,827	1,016	59	6,230
2034		4,767	24	3,769	974	57	6,287
2035		4,663	23	3,706	934	55	6,341
2036		4,555	22	3,639	894	52	6,394
2037		4,443	21	3,567	855	50	6,444
2038		4,325	20	3,489	816	48	6,492
2039		4,201	19	3,405	778	45	6,537
2040		4,073	18	3,316	739	43	6,580
2041		3,939	17	3,220	701	41	6,621
2042		3,799	16	3,120	663	38	6,660
2043		3,655	16	3,014	625	36	6,696
2044		3,506	15	2,903	588	34	6,730
2045		3,352	14	2,787	551	32	6,761
2046		3,193	13	2,666	514	29	6,791
2047		3,030	13	2,540	477	27	6,818
2048		2,861	12	2,409	440	25	6,843
2049		2,687	11	2,273	403	23	6,865
2050		2,508	10	2,132	366	21	6,886
2051		2,324	9	1,987	329	18	6,905
2052		2,138	8	1,838	292	16	6,921
2053		1,958	7	1,692	259	14	6,935

Year	Incidence	PLWHA				AIDS deaths	
		Total	CD4>500	CD4<500	AIDS	Annual	Cum.
2054		1,790	7	1,553	231	13	6,948
2055		1,635	6	1,423	207	11	6,960
2056		1,490	6	1,298	186	10	6,970
2057		1,350	5	1,178	166	9	6,979
2058		1,214	5	1,061	148	8	6,987
2059		1,083	4	948	131	7	6,994
2060		958	4	839	115	6	7,000
2061		840	3	736	100	5	7,006
2062		729	3	640	87	5	7,010
2063		627	2	550	74	4	7,014
2064		534	2	468	63	3	7,018
2065		449	2	394	53	3	7,020
2066		372	1	326	44	2	7,023
2067		300	1	264	35	2	7,024
2068		235	1	206	28	1	7,026
2069		176	1	154	21	1	7,027
2070		124	0	109	15	1	7,028
2071		81	0	71	10	0	7,028
2072		48	0	42	6	0	7,028
2073		24	0	21	3	0	7,028
2074		11	0	10	1	0	7,029
2075		9	0	8	1	0	7,029
2076		7	0	6	1	0	7,029
2077		6	0	5	1	0	7,029
2078		4	0	4	1	0	7,029
2079		3	0	3	0	0	7,029
2080		2	0	2	0	0	7,029
2081		2	0	2	0	0	7,029
2082		2	0	2	0	0	7,029
2083		2	0	1	0	0	7,029
2084		1	0	1	0	0	7,029
2085		1	0	1	0	0	7,029
2086		1	0	1	0	0	7,029
2087		1	0	1	0	0	7,029
2088		0	0	0	0	0	7,029
2089		0	0	0	0	0	7,029
2090		0	0	0	0	0	7,029

C

MODELLED HIV INCIDENCE AND PREVALENCE, ALTERNATIVE (NO INTERVENTION) SCENARIO, 1980-2005.

Year	Incidence	PLWHA				AIDS deaths	
		Total	CD4>500	CD4<500	AIDS	Annual	Cum.
1980	0	0	0	0	0	0	0
1981	56	56	56	0	0	0	0
1982	378	434	430	4	0	0	0
1983	1,147	1,577	1,540	34	3	2	2
1984	1,649	3,215	3,045	156	14	9	11
1985	1,547	4,732	4,255	436	41	28	39
1986	1,313	5,980	5,004	888	89	63	102
1987	1,133	6,998	5,369	1,474	155	114	216
1988	1,012	7,830	5,462	2,132	236	178	393
1989	988	8,566	5,439	2,801	326	251	644
1990	1,041	9,277	5,422	3,434	420	328	972
1991	1,081	9,948	5,426	4,007	515	408	1,380
1992	1,127	10,586	5,470	4,509	608	486	1,866
1993	1,192	11,213	5,573	4,943	697	563	2,429
1994	1,271	11,845	5,746	5,317	782	636	3,064
1995	1,395	12,531	6,023	5,646	862	705	3,769
1996	1,350	13,570	6,415	5,964	1,190	306	4,075
1997	1,586	14,956	6,998	6,556	1,402	192	4,267
1998	1,962	16,775	7,907	7,222	1,647	130	4,398
1999	2,551	19,190	9,333	7,942	1,915	122	4,520
2000	3,285	22,336	11,380	8,747	2,208	119	4,638
2001	4,021	26,200	13,951	9,729	2,520	133	4,771
2002	5,009	31,029	17,220	10,953	2,856	149	4,920
2003	5,839	36,664	20,939	12,496	3,229	169	5,089
2004	6,682	43,113	25,039	14,423	3,650	191	5,280
2005	7,423	50,271	29,347	16,789	4,135	218	5,498
2006		50,015	25,689	19,628	4,698	248	5,746
2007		49,724	21,864	22,530	5,329	283	6,029
2008		49,396	18,262	25,133	6,001	319	6,348
2009		49,031	15,066	27,277	6,688	355	6,703

Year	Incidence	PLWHA				AIDS deaths	
		Total	CD4>500	CD4<500	AIDS	Annual	Cum.
2010		48,630	12,349	28,917	7,365	390	7,093
2011		48,196	10,105	30,080	8,010	422	7,515
2012		47,730	8,287	30,836	8,607	452	7,967
2013		47,237	6,830	31,268	9,140	478	8,445
2014		46,720	5,664	31,459	9,597	500	8,946
2015		46,183	4,728	31,483	9,973	519	9,465
2016		45,630	3,970	31,398	10,262	533	9,998
2017		45,064	3,349	31,249	10,465	544	10,541
2018		44,489	2,836	31,068	10,585	550	11,091
2019		43,909	2,408	30,876	10,626	553	11,645
2020		43,327	2,048	30,684	10,595	553	12,198
2021		42,745	1,745	30,500	10,500	551	12,749
2022		42,164	1,490	30,325	10,349	545	13,294
2023		41,587	1,274	30,161	10,152	538	13,832
2024		41,015	1,094	30,004	9,917	529	14,362
2025		40,447	942	29,853	9,651	519	14,880
2026		39,884	817	29,704	9,363	507	15,387
2027		39,326	712	29,554	9,060	495	15,882
2028		38,774	627	29,401	8,746	481	16,363
2029		38,226	556	29,242	8,428	468	16,831
2030		37,683	499	29,075	8,109	454	17,285
2031		37,144	453	28,899	7,793	440	17,725
2032		36,609	415	28,712	7,482	426	18,150
2033		36,077	385	28,513	7,179	411	18,562
2034		35,545	361	28,300	6,884	397	18,959
2035		35,012	341	28,071	6,600	383	19,342
2036		34,475	326	27,825	6,325	369	19,711
2037		33,932	313	27,560	6,059	355	20,067
2038		33,380	303	27,274	5,804	342	20,409
2039		32,817	294	26,965	5,558	329	20,737
2040		32,240	287	26,632	5,321	315	21,053
2041		31,647	281	26,273	5,093	303	21,355
2042		31,036	276	25,886	4,873	290	21,645
2043		30,403	271	25,471	4,661	277	21,922
2044		29,748	266	25,025	4,457	265	22,187
2045		29,067	261	24,547	4,258	253	22,441
2046		28,358	257	24,035	4,066	241	22,682
2047		27,617	252	23,486	3,879	230	22,911
2048		26,841	247	22,899	3,696	218	23,130
2049		26,029	242	22,271	3,516	207	23,336
2050		25,175	236	21,600	3,339	196	23,532
2051		24,278	230	20,884	3,164	185	23,717

Year	Incidence	PLWHA				AIDS deaths	
		Total	CD4>500	CD4<500	AIDS	Annual	Cum.
2052		23,336	223	20,121	2,991	174	23,890
2053		22,353	216	19,315	2,822	163	24,053
2054		21,332	209	18,467	2,657	152	24,206
2055		20,270	201	17,575	2,495	142	24,348
2056		19,165	192	16,639	2,335	132	24,480
2057		18,015	182	15,658	2,175	122	24,603
2058		16,823	172	14,634	2,016	112	24,715
2059		15,595	161	13,576	1,857	103	24,818
2060		14,344	149	12,495	1,700	93	24,911
2061		13,081	138	11,400	1,544	84	24,995
2062		11,819	125	10,304	1,390	75	25,070
2063		10,570	113	9,217	1,240	66	25,136
2064		9,345	101	8,150	1,094	58	25,194
2065		8,156	89	7,113	954	50	25,245
2066		7,007	77	6,111	819	43	25,287
2067		5,904	65	5,150	689	36	25,323
2068		4,853	54	4,233	567	29	25,352
2069		3,868	43	3,374	452	23	25,375
2070		2,964	33	2,585	346	18	25,392
2071		2,154	25	1,878	251	13	25,405
2072		1,464	17	1,276	171	9	25,414
2073		915	11	797	107	5	25,419
2074		535	6	466	62	3	25,422
2075		348	4	303	41	2	25,424
2076		159	2	139	19	1	25,425
2077		136	2	119	16	1	25,426
2078		113	1	99	13	1	25,426
2079		92	1	80	11	1	25,427
2080		72	1	62	8	0	25,427
2081		64	1	56	8	0	25,428
2082		57	1	50	7	0	25,428
2083		50	1	44	6	0	25,428
2084		43	0	37	5	0	25,428
2085		36	0	31	4	0	25,429
2086		29	0	25	3	0	25,429
2087		21	0	19	3	0	25,429
2088		14	0	12	2	0	25,429
2089		7	0	6	1	0	25,429
2090		0	0	0	0	0	25,429

D

MODELLED HIV INCIDENCE AND PREVALENCE, BASELINE SCENARIO, 2006 –2016.

Year	Incidence	PLWHA				AIDS deaths	
		Total	CD4>500	CD4<500	AIDS	Annual	Cum.
2006	339	7,829	1,999	4,160	1,670	85	3,973
2007	339	8,077	2,059	4,302	1,716	88	4,061
2008	339	8,322	2,108	4,456	1,757	90	4,151
2009	339	8,564	2,149	4,621	1,794	93	4,244
2010	339	8,804	2,182	4,793	1,828	95	4,339
2011	339	9,040	2,210	4,971	1,860	97	4,437
2012	339	9,275	2,232	5,152	1,890	100	4,536
2013	339	9,507	2,251	5,336	1,919	102	4,638
2014	339	9,736	2,267	5,522	1,947	104	4,742
2015	339	9,962	2,280	5,708	1,975	106	4,847
2016	339	10,187	2,291	5,893	2,003	108	4,955
2017		10,070	1,961	6,079	2,030	109	5,065
2018		9,950	1,650	6,245	2,055	111	5,176
2019		9,828	1,372	6,378	2,078	113	5,289
2020		9,704	1,132	6,475	2,097	114	5,403
2021		9,578	932	6,536	2,110	115	5,517
2022		9,449	767	6,566	2,117	115	5,633
2023		9,320	633	6,570	2,116	115	5,748
2024		9,189	525	6,555	2,109	115	5,864
2025		9,057	437	6,525	2,094	115	5,978
2026		8,924	366	6,485	2,073	114	6,092
2027		8,790	308	6,438	2,044	112	6,204
2028		8,655	260	6,386	2,010	110	6,314
2029		8,520	219	6,331	1,969	108	6,423
2030		8,384	186	6,274	1,924	106	6,529
2031		8,247	158	6,214	1,875	104	6,633
2032		8,108	135	6,152	1,822	101	6,734
2033		7,969	115	6,087	1,767	98	6,833
2034		7,827	98	6,019	1,709	96	6,928
2035		7,683	85	5,948	1,650	93	7,021
2036		7,535	73	5,872	1,590	90	7,110

Year	Incidence	PLWHA				AIDS deaths	
		Total	CD4>500	CD4<500	AIDS	Annual	Cum.
2037		7,383	64	5,791	1,528	86	7,197
2038		7,226	56	5,704	1,466	83	7,280
2039		7,064	49	5,611	1,404	80	7,360
2040		6,898	44	5,512	1,342	76	7,436
2041		6,726	39	5,407	1,280	73	7,509
2042		6,550	35	5,296	1,219	70	7,579
2043		6,369	32	5,178	1,159	66	7,646
2044		6,183	29	5,055	1,099	63	7,709
2045		5,993	27	4,925	1,041	60	7,769
2046		5,799	25	4,790	983	57	7,825
2047		5,599	23	4,649	927	54	7,879
2048		5,394	22	4,501	871	50	7,929
2049		5,183	20	4,346	816	47	7,976
2050		4,967	19	4,186	762	44	8,020
2051		4,745	18	4,019	709	41	8,062
2052		4,520	17	3,847	657	38	8,100
2053		4,299	16	3,675	608	35	8,135
2054		4,090	15	3,509	566	33	8,168
2055		3,892	14	3,349	529	31	8,199
2056		3,701	13	3,193	494	29	8,227
2057		3,513	12	3,038	462	27	8,254
2058		3,326	12	2,883	432	25	8,279
2059		3,141	11	2,727	403	23	8,302
2060		2,957	10	2,572	375	21	8,323
2061		2,776	10	2,417	349	20	8,343
2062		2,597	9	2,265	323	18	8,362
2063		2,422	9	2,114	299	17	8,378
2064		2,250	8	1,966	276	15	8,394
2065		2,082	7	1,821	254	14	8,408
2066		1,916	7	1,677	232	13	8,421
2067		1,751	6	1,534	211	12	8,433
2068		1,588	6	1,392	190	10	8,443
2069		1,427	5	1,252	171	9	8,452
2070		1,272	5	1,116	151	8	8,460
2071		1,122	4	985	133	7	8,467
2072		980	4	860	116	6	8,474
2073		847	3	743	100	5	8,479
2074		722	3	634	85	4	8,483
2075		608	2	534	72	4	8,487
2076		503	2	442	59	3	8,490
2077		409	1	359	48	2	8,493
2078		324	1	284	38	2	8,495

Year	Incidence	PLWHA				AIDS deaths	
		Total	CD4>500	CD4<500	AIDS	Annual	Cum.
2079		249	1	218	29	1	8,496
2080		184	1	161	22	1	8,497
2081		128	0	112	15	1	8,498
2082		83	0	73	10	0	8,498
2083		49	0	43	6	0	8,499
2084		25	0	22	3	0	8,499
2085		11	0	10	1	0	8,499
2086		9	0	8	1	0	8,499
2087		6	0	6	1	0	8,499
2088		5	0	4	1	0	8,499
2089		3	0	3	0	0	8,499
2090		2	0	2	0	0	8,499
2091		2	0	2	0	0	8,499
2092		2	0	1	0	0	8,499
2093		1	0	1	0	0	8,499
2094		1	0	1	0	0	8,499
2095		1	0	1	0	0	8,499
2096		1	0	1	0	0	8,499
2097		1	0	1	0	0	8,499
2098		0	0	0	0	0	8,499
2099		0	0	0	0	0	8,499
2100		0	0	0	0	0	8,499

E

MODELLED HIV INCIDENCE AND PREVALENCE, ALTERNATIVE (TERMINATED INTERVENTION) SCENARIO, 2006 –2016.

Year	Incidence	PLWHA				AIDS deaths	
		Total	CD4>500	CD4<500	AIDS	Annual	Cum.
2006	342	7,831	2,002	4,160	1,670	85	3,973
2007	388	8,128	2,110	4,302	1,716	88	4,061
2008	502	8,535	2,319	4,459	1,757	90	4,151
2009	639	9,077	2,644	4,637	1,795	93	4,244
2010	813	9,789	3,111	4,846	1,832	95	4,339
2011	1,036	10,720	3,751	5,098	1,870	98	4,438
2012	1,329	11,939	4,614	5,413	1,913	101	4,539
2013	1,513	13,338	5,563	5,811	1,964	104	4,643
2014	1,760	14,977	6,639	6,310	2,028	109	4,752
2015	2,068	16,916	7,882	6,925	2,109	114	4,865
2016	2,482	19,261	9,378	7,671	2,212	120	4,985
2017		19,125	8,215	8,568	2,342	127	5,112
2018		18,979	6,995	9,487	2,497	136	5,249
2019		18,823	5,844	10,312	2,668	146	5,395
2020		18,657	4,821	10,989	2,847	155	5,550
2021		18,479	3,950	11,504	3,025	165	5,715
2022		18,292	3,229	11,866	3,197	173	5,888
2023		18,095	2,645	12,094	3,355	181	6,069
2024		17,890	2,177	12,217	3,496	188	6,257
2025		17,677	1,802	12,260	3,615	193	6,451
2026		17,458	1,501	12,247	3,710	198	6,649
2027		17,233	1,257	12,196	3,779	201	6,850
2028		17,003	1,058	12,123	3,822	203	7,053
2029		16,770	893	12,036	3,841	204	7,257
2030		16,534	755	11,943	3,835	204	7,460
2031		16,295	640	11,848	3,807	202	7,663
2032		16,055	543	11,753	3,760	200	7,863
2033		15,813	461	11,657	3,695	198	8,060
2034		15,569	391	11,562	3,616	194	8,255
2035		15,323	333	11,465	3,525	190	8,445

Year	Incidence	PLWHA				AIDS deaths	
		Total	CD4>500	CD4<500	AIDS	Annual	Cum.
2036		15,075	285	11,366	3,424	186	8,630
2037		14,823	244	11,264	3,315	181	8,811
2038		14,567	210	11,156	3,200	175	8,986
2039		14,308	183	11,043	3,082	170	9,156
2040		14,046	160	10,924	2,962	164	9,321
2041		13,779	141	10,798	2,840	159	9,479
2042		13,510	126	10,665	2,719	153	9,632
2043		13,237	113	10,524	2,600	147	9,779
2044		12,961	103	10,376	2,482	141	9,921
2045		12,682	95	10,220	2,367	135	10,056
2046		12,399	88	10,057	2,254	130	10,186
2047		12,112	83	9,885	2,145	124	10,310
2048		11,821	78	9,705	2,038	118	10,428
2049		11,523	74	9,515	1,934	113	10,541
2050		11,220	71	9,316	1,833	107	10,648
2051		10,911	68	9,108	1,735	102	10,750
2052		10,598	66	8,892	1,641	97	10,847
2053		10,288	64	8,672	1,553	92	10,939
2054		9,988	62	8,454	1,472	87	11,026
2055		9,697	60	8,239	1,398	83	11,109
2056		9,409	59	8,022	1,329	79	11,188
2057		9,122	58	7,801	1,264	75	11,262
2058		8,832	56	7,575	1,201	71	11,333
2059		8,539	55	7,342	1,142	67	11,401
2060		8,241	54	7,103	1,085	64	11,464
2061		7,939	52	6,857	1,030	60	11,525
2062		7,631	51	6,604	976	57	11,582
2063		7,318	49	6,344	924	54	11,635
2064		6,998	48	6,076	874	50	11,686
2065		6,669	46	5,798	824	47	11,733
2066		6,328	44	5,509	775	44	11,777
2067		5,974	42	5,206	726	41	11,818
2068		5,606	40	4,890	676	38	11,856
2069		5,227	38	4,562	626	35	11,891
2070		4,838	36	4,226	577	32	11,923
2071		4,444	33	3,883	527	29	11,952
2072		4,047	31	3,538	479	26	11,978
2073		3,653	28	3,194	431	23	12,001
2074		3,262	25	2,852	384	20	12,021
2075		2,877	23	2,516	338	18	12,039
2076		2,501	20	2,187	293	15	12,055
2077		2,136	17	1,868	250	13	12,068

Year	Incidence	PLWHA				AIDS deaths	
		Total	CD4>500	CD4<500	AIDS	Annual	Cum.
2078		1,785	15	1,561	209	11	12,078
2079		1,452	12	1,270	170	9	12,087
2080		1,141	10	998	134	7	12,094
2081		858	8	750	100	5	12,099
2082		612	6	535	72	4	12,103
2083		404	4	353	47	2	12,105
2084		243	2	212	28	1	12,106
2085		134	1	117	16	1	12,107
2086		91	1	79	11	1	12,108
2087		41	0	36	5	0	12,108
2088		33	0	29	4	0	12,108
2089		24	0	21	3	0	12,108
2090		16	0	14	2	0	12,108
2091		14	0	13	2	0	12,108
2092		13	0	11	2	0	12,109
2093		11	0	10	1	0	12,109
2094		10	0	8	1	0	12,109
2095		8	0	7	1	0	12,109
2096		6	0	6	1	0	12,109
2097		5	0	4	1	0	12,109
2098		3	0	3	0	0	12,109
2099		2	0	1	0	0	12,109
2100		0	0	0	0	0	12,109